Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges

Draft Comprehensive Conservation Plan

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Acronyms and Abbreviations

2047	Colusa Basin Drain
ACOE	U.S. Army Corps of Engineers
ADA	Americans with Disabilities Act
AHMP	Annual Habitat Management Plan
AHPA	Archaeological and Historic Preservation Act
ARPA	Archaeological Resources Protection Act
ATV	All terrain vehicle
BLM	Bureau of Land Management
BMP	Best Management Practice
BOR	Bureau of Reclamation
CALFED	California Bay-Delta Program
Cal Fire	California Fire (also California Department of Forestry, CDF)
CCP	Comprehensive Conservation Plan
CD	Compatibility Determination
CDF	California Department of Forestry (also, Cal Fire)
CDFG	California Department of Fish and Game
CDPR	California Department of Parks and Recreation
Cfs	Cubic feet per second
CFR	Code of Federal Regulations
CVJV	Central Valley Joint Venture
Complex	Sacramento National Wildlife Refuge Complex
CSU Chico	California State University at Chico
CWA	California Waterfowl Association
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
DMBM	Division of Migratory Bird Management
DOI	Department of the Interior
DU	Ducks Unlimited
DWR	Department of Water Resources
EA	Environmental Assessment
EE	Environmental Education
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
FR	Federal Register
FTE	Full-time Equivalent
FY	Fiscal Year
GIS	Global Information System
GCID	Glenn-Colusa Irrigation District
GGS	Giant Garter Snake
GPS	Global Positioning System
Improvement Act	National Wildlife Refuge System Improvement Act of 1997
IPM	Integrated Pest Management
MOU	Memorandum of Understanding
MRF	Mixed riparian forest
NEPA	National Environmental Policy Act

NRHP	National Register of Historic Places
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NOA	Notice of Availability
NWR	National Wildlife Refuge (also, Refuge)
NWRS	National Wildlife Refuge System (also, Refuge System)
PRBO	Point Reyes Bird Observatory, PRBO Conservation Science
PUP	Pesticide Use Permit
Refuge	National Wildlife Refuge (also, NWR)
Refuge System	National Wildlife Refuge System (also, NWRS)
Service	U.S. Fish and Wildlife Service (also, USFWS)
SoC	Species of Concern
SUP	Special Use Permit
SFW	Seasonally flooded wetland
SW	Summer water
T&E	Threatened and Endangered Species
TNC	The Nature Conservancy
USFWS	U.S. Fish and Wildlife Service (also, Service)
USGS	U.S. Geological Survey
VORF	Valley oak riparian forest
WG	Watergrass
WMA	Wildlife Management Area
WS	Willow scrub
WUI	Wildland Urban Interface

Chapter 1. Introduction and Background

1. Introduction

This document is a Draft Comprehensive Conservation Plan (CCP) designed to guide management of Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges (Refuges) for the next fifteen years. The U. S. Fish and Wildlife Service (Service) manages the Refuges as part of the Sacramento National Wildlife Refuge Complex (Complex) located in the Sacramento Valley of California (Figure 1) approximately ninety miles north of the city of Sacramento.

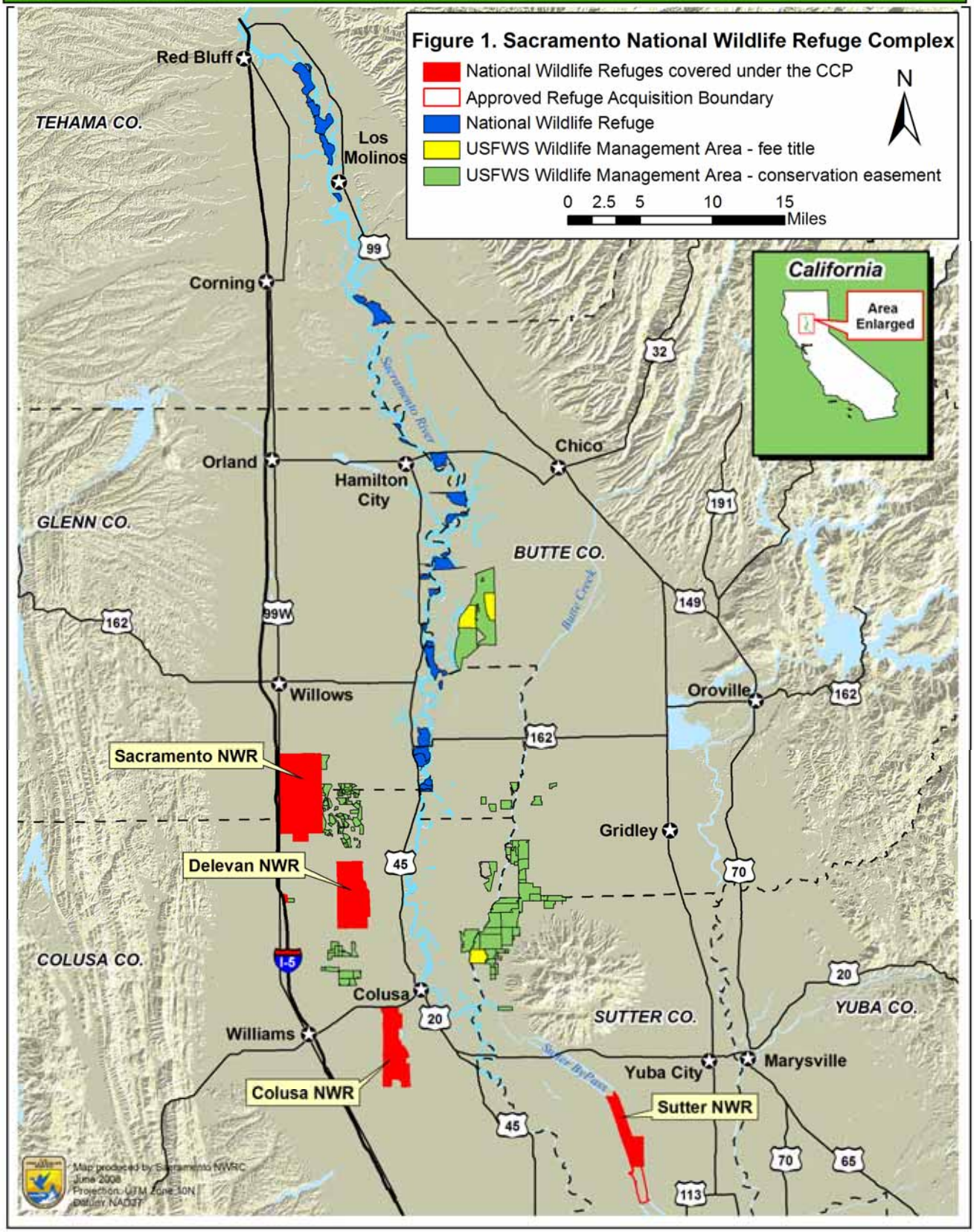
The Draft CCP and accompanying Environmental Assessment (EA) address the Service's legal mandates, policies, goals, and National Environmental Policy Act (NEPA) compliance. The EA (Appendix A) presents a range of administrative, habitat management, and visitor services alternatives that consider issues and opportunities on the Refuges. The Service's initial proposal for future management of the Refuges is presented in the EA. Chapter 4 of the CCP describes the goals, objectives, and strategies for the Service's preferred alternative (Alternative C). The final CCP will be developed through modifications made during the internal and public review processes.

The CCP is accompanied by new and/or updated plans: a Hunting Plan (Appendix C), Visitor Services Plan (Appendix D), Integrated Pest Management Plan (Appendix F), Inventory and Monitoring Plan (Appendix G), Waterfowl Disease Contingency Plan (Appendix H), and Tree Reduction Operations Plan (Appendix P). Other existing plans that will remain in place include annual Habitat Management Plans (Appendix E), annual Water Management Plans (Appendix I), Fire Management Plan (Appendix J), Continuity of Operations Plan, and Safety Plan.

The CCP is divided into five chapters: Chapter 1, Introduction; Chapter 2, Planning Process; Chapter 3, Refuge Environment; Chapter 4, Planned Refuge Management and Programs; and Chapter 5, Plan Implementation.

Sacramento National Wildlife Refuge
Photo by Steve Emmons

Sacramento National Wildlife Refuge Complex



2. Purpose of and Need for Plan

Currently, individual Refuge Management Plans (USFWS 1988) guide the Sacramento, Delevan, Colusa, and Sutter Refuges. The National Wildlife Refuge System Improvement Act of 1997 (16 United States Code [USC] 668dd-668ee) (Improvement Act) requires that all refuges be managed in accordance with an approved CCP by 2012. Under the Improvement Act, the National Wildlife Refuge System (Refuge System) is to be consistently directed and managed to fulfill the specific purpose(s) for which each refuge was established as well as the Refuge System Mission. The planning process helps the Service achieve the refuge purposes and the Refuge System mission by identifying specific goals, objectives, and strategies to implement on each Refuge.

The purposes of this CCP are to:

- Provide a clear statement of direction for the future management of the Refuges.
- Provide long-term continuity in Refuge management.
- Communicate the Service's management priorities for the Refuges to their partners, neighbors, visitors, and the general public.
- Provide an opportunity for the public to help shape the future management of the Refuges.
- Ensure that management programs on the Refuges are consistent with the mandates of the Refuge System and the purposes for which the Refuges were established.
- Ensure that the management of the Refuges is consistent with Federal, State, and local plans.
- Provide a basis for budget requests to support the Refuges' needs for staffing, operations, maintenance, and capital improvements.

3. Legal and Policy Guidance

National Wildlife Refuges are guided by the purposes of the individual refuge, mission and goals of the Refuge System, and Service policy, laws, and international treaties. Relevant guidance includes the National Wildlife Refuge System Administration Act of 1966, as amended by the Improvement Act, Refuge Recreation Act of 1962, selected portions of the Code of Federal Regulations, and the Service Manual.

Refuges are also governed by a variety of other laws, treaties and executive orders pertaining to the conservation and protection of natural and cultural resources (refer to Appendix M for additional information about these laws and executive orders).

3.1. National Wildlife Refuge System Improvement Act

The Improvement Act, which amends the National Wildlife Refuge System Administration Act of 1966, provides comprehensive legislation on how the Refuge System should be managed and used by the public. The Improvement Act:

- Identified a new mission statement for the Refuge System.
- Established six priority public uses (hunting, fishing, wildlife observation and photography, environmental education and interpretation).
- Emphasized conservation and enhancement of the quality and diversity of fish and wildlife habitat.
- Stressed the importance of partnerships with Federal and State agencies, Tribes, non-governmental organizations, industry, and the general public.
- Mandated public involvement in decisions on the acquisition and management of refuges.
- Required, prior to acquisition of new refuge lands, identification of existing compatible wildlife-dependent uses that would be permitted to continue on an interim basis pending completion of comprehensive conservation planning.

The Improvement Act establishes the responsibilities of the Secretary of the Interior for managing and protecting the Refuge System; requires a CCP for each refuge by the year 2012; and provides guidelines and directives for the administration and management of all areas in the Refuge System, including wildlife refuges, areas for the protection and conservation of fish and wildlife threatened with extinction, wildlife ranges, game ranges, wildlife management areas, or waterfowl production areas.

3.2. Appropriate Use Policy

This policy describes the initial decision process the refuge manager follows when first considering whether or not to allow a proposed use on a refuge. The refuge manager must find a use appropriate before undertaking a compatibility review of the use. An appropriate use, as defined by the Appropriate Use Policy (603 FW 1 of the Service Manual), is a proposed or existing use on a refuge that meets at least one of the following four conditions:

- The use is a wildlife-dependant recreational use as identified in the Improvement Act.
- The use contributes to the fulfilling of the refuge purpose(s), the Refuge System mission, or goals or objectives described in a refuge management plan approved after October 9, 1997, the date the Improvement Act was signed into law.
- The use involves the take of fish and wildlife under State regulations.
- The use has been found to be appropriate as specified in section 1.11 (603 FW 1 of the Service Manual).

If an existing use is not appropriate, the refuge manager will eliminate or modify the use as expeditiously as practicable. If a new use is not appropriate, the refuge manager will deny the use without determining compatibility. If a use is determined to be an appropriate

refuge use, the refuge manager will then determine if the use is compatible (see Compatibility section below). Although a use may be both appropriate and compatible, the refuge manager retains the authority to not allow the use or modify the use. Uses that have been administratively determined to be appropriate are the six wildlife-dependent recreational uses (hunting, fishing, wildlife observation and photography, environmental education, and interpretation) and take of fish and wildlife under State regulations.

3.3. Compatibility Policy

Lands within the Refuge System are different from other multiple use public lands in that they are closed to all public uses unless specifically and legally opened. The Improvement Act states "... the Secretary shall not initiate or permit a new use of a Refuge or expand, renew, or extend an existing use of a Refuge, unless the Secretary has determined that the use is a compatible use and that the use is not inconsistent with public safety."

In accordance with the Improvement Act, the Service has adopted a Compatibility Policy (603 FW 2 of the Service Manual) that includes guidelines for determining if a use proposed on a National Wildlife Refuge is compatible with the purposes for which the refuge was established. A compatible use is defined in the policy as a proposed or existing wildlife-dependent recreational use or any other use of a National Wildlife Refuge that, based on sound professional judgment, will not materially interfere with or detract from the fulfillment of the Refuge System mission or the purposes of the Refuge. Sound professional judgment is defined as a finding, determination, or decision that is consistent with the principles of sound fish and wildlife management and administration, available science and resources (funding, personnel, facilities, and other infrastructure), and applicable laws. The Service strives to provide priority public uses when they are compatible. If financial resources are not available to design, operate, and maintain a priority use, the refuge manager will take reasonable steps to obtain outside assistance from the State and other conservation interests.

When a determination is made as to whether a proposed use is compatible or not, this determination is provided in writing and is referred to as a compatibility determination. An opportunity for public review and comment is required for all compatibility determinations. For compatibility determinations prepared concurrently with a CCP or step-down management plan, the opportunity for public review and comment is provided during the public review period for the draft plan and associated NEPA document.

3.4. Biological Integrity, Diversity and Environmental Health Policy

In addition, the Improvement Act directs the Service to "ensure that the biological integrity, diversity, and environmental health of the Refuge System are maintained for the benefit of present and future generations of Americans..." To implement this directive, the Service has issued the Biological Integrity, Diversity and Environmental Health Policy (601 FW 3 of the Service Manual), which provides policy for maintaining and restoring, where appropriate, the biological integrity, diversity, and environmental health of the Refuge System. The policy is an additional directive for refuge managers to follow while achieving Refuge purpose(s) and Refuge System mission. It provides for the consideration and protection of the broad spectrum of fish, wildlife, and habitat resources found on Refuges and associated ecosystems. Further, it provides refuge managers with an evaluation process to analyze their refuge and recommend the best management direction to prevent further degradation of environmental conditions and restore lost or severely degraded components where appropriate and in concert with refuge purposes and the Refuge System mission. When evaluating the appropriate management direction for refuges, refuge managers will use sound professional judgment to determine their refuges' contribution to biological integrity, diversity, and environmental health at multiple landscape scales.

Greater white-fronted goose
Photo by Mike Peters

4. The U.S. Fish and Wildlife Service

The Service is the primary Federal agency responsible for conserving, protecting, and enhancing fish and wildlife and their habitats for the continuing benefit of the American people. Although the Service shares this responsibility with other Federal, State, Tribal, local, and private entities, the Service has specific responsibilities for migratory birds, threatened and endangered species, anadromous and interjurisdictional fish, and certain marine mammals. These are referred to as Federal Trust Species. The Service also manages the Refuge System and National Fish Hatcheries; enforces Federal wildlife laws and international treaties on importing and exporting wildlife; assists State fish and wildlife programs; and helps other countries develop wildlife conservation programs.

The mission of the Service is:
"Working with others to conserve, protect, and enhance fish, wildlife and plants and their habitats for the continuing benefit of the American people."

5. The National Wildlife Refuge System

In 1903, President Theodore Roosevelt named Florida's Pelican Island the nation's first bird sanctuary, which along with other sanctuaries and preserves evolved into the National Wildlife Refuge System. Since that time, the Refuge System has grown to more than 97 million acres. It includes 548 refuges, at least one in every state and many U.S. territories, and over 3,000 Waterfowl Production Areas. The Refuge System is the world's largest collection of lands and waters set aside specifically for the conservation of wildlife and ecosystem protection. The needs of wildlife and their habitats come first on refuges, in contrast to other public lands managed for multiple uses. The Refuge System provides important habitat for native plants and many species of mammals, birds, fish, and threatened and endangered species.

The mission of the Refuge System, as stated in the Improvement Act, is:

"To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans" (16 USC 668dd et seq.).

The goals of the Refuge System, as defined in the Refuge System Mission and Goals and Refuge Purposes Policy (601 FW 1 of the Service Manual) are to:

- Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered.
- Develop and maintain a network of habitats for migratory birds, anadromous and interjurisdictional fish, and marine mammal populations that is strategically distributed and carefully managed to meet important life history needs of these species across their ranges.
- Conserve those ecosystems, plant communities, wetlands of national or international significance, and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts.
- Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation).

- Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.

Collectively, these goals articulate the foundation for our stewardship of the Refuge System and define the unique and important niche it occupies among the various Federal land systems. These goals will help guide development of specific management priorities during development of CCPs.

In addition, the guiding principles of the Refuge System are:

- We are land stewards, guided by Aldo Leopold's teachings that land is a community of life and that love and respect for the land is an extension of ethics. We seek to reflect that land ethic in our stewardship and to instill it in others.
- Wild lands and the perpetuation of diverse and abundant wildlife are essential to the quality of the American life.
- We are public servants. We owe our employers, the American people, hard work, integrity, fairness, and a voice in the protection of their trust resources.
- Management, ranging from preservation to active manipulation of habitats and populations, is necessary to achieve Refuge System and Service missions.
- Wildlife-dependent uses involving hunting, fishing, wildlife observation, photography, interpretation, and education, when compatible, are legitimate and appropriate uses of the Refuge System.
- Partnerships with those who want to help us meet our mission are welcome and indeed essential.
- Employees are our most valuable resource. They are respected and deserve an empowering, mentoring, and caring work environment.
- We respect the rights, beliefs, and opinions of our neighbors.

6. The Sacramento National Wildlife Refuge Complex

For thousands of years the Sacramento Valley has provided a winter haven for ducks, geese, and swans. Waterfowl migrate here by the millions from as far away as the Arctic regions of Alaska, Canada, and Siberia. The five national wildlife refuges and three wildlife management areas of the Sacramento National Wildlife Refuge Complex (Complex) represent an island of habitat in a sea of Sacramento Valley agriculture (Figure 1).

The Valley is an extensive agricultural area that has historically been a major wintering area for millions of ducks and geese. Lands that surround the Refuges are mostly irrigated rice lands. Some dairy production as well as various crops including safflower, barley, wheat, and alfalfa is also present. The Valley is bordered by the Sierra Nevada Range to the east and Coast Range to the west. Topography is flat with a gentle slope to the southeast towards the Sacramento River. Predominant soil types are poorly drained alkaline clays.

The Complex represents a small portion of the vast seasonal wetlands and grasslands that once existed in the Sacramento Valley. Millions of waterfowl migrated south in the Pacific Flyway to winter in the Valley among resident waterbirds, deer, elk, pronghorn, and grizzly bear. Natural habitat was replaced with rice and other crops with the development of agriculture during the late 1800s and early 1900s. Waterfowl substituted some of these farm crops for their original wetland foods, causing serious crop losses for farmers.

Today, 90 to 95 percent of California's wetlands are gone, along with the grizzly bear (Holland 1978, Gilmer et al. 1982, Frayer et al. 1989, Kempka and Kollasch 1990). Constructed levees now confine the rivers for irrigation and flood control, preventing the natural flooding of wetlands. Despite these changes, birds continue to fly their ancient migration routes along the Pacific Flyway and crowd into the remaining wintering habitat. The Complex provides a significant amount of the wintering habitat that supports waterfowl and many other migratory birds in the Sacramento Valley. The Complex currently supports nearly 300 species of birds.

In 1937, when Sacramento National Wildlife Refuge was established, Refuge staff worked to transform many of the Refuge's dry, alkaline lands into productive managed wetlands. Some of these areas were used for growing grain crops to attract waterfowl away from crops on private lands. Three additional Refuges were created in the 1940s through the 1980s, forming the Sacramento National Wildlife Refuge Complex. These Refuges, including Delevan, Colusa, and Sutter, were established to provide wintering habitat for waterfowl and in some cases to reduce crop damage. The Refuges consist of approximately 23,000 acres of wetlands, vernal pools, alkali meadows, grassland, and riparian habitats. During spring, the Refuges drain seasonal wetlands, the most common habitat type, and allow them to dry out over the summer to encourage plant growth on the moist, exposed soil. Re-flooding in the fall makes seeds and plants available for wildlife. Water management, prescribed burns, disking, and mowing are some of the techniques used to manage wetland habitats.

The fifth refuge, Sacramento River Refuge, was established in 1989 to help protect and restore riparian habitat along the Sacramento River as it meanders through the Sacramento Valley from Red Bluff to Colusa. This Refuge is not included in this CCP and is covered under the Sacramento River Refuge Final CCP released in July 2005.

The Complex's three wildlife management areas North Central Valley, Willow Creek – Lurline, and Butte Sink, are also not included in this CCP. These areas will be addressed in a separate CCP at a later date.

7. Sacramento National Wildlife Refuge

In January 1937, the Federal government purchased the 10,775-acre Spalding Ranch, located south of "The Willows" and christened it the Sacramento Migratory Waterfowl Refuge. It was established by Executive Order 7562 and was acquired with funds from the Emergency Conservation Fund Act of 1933 to provide refuge and breeding habitat for migratory birds and other wildlife. In 1971, eight additional acres were purchased with Land and Water Conservation Funds increasing the Refuge to 10,783 acres. In 2003, the State of California Conservation Board donated the 36-acre Goldworthy property to the Refuge to protect the site from proposed commercial development.

Entrance sign (1938)
USFWS Photo

The Refuge was created on an open plain of short grasses, shrubs, and forbs known as the Colusa Plains. This area has a gradual slope to the southeast toward the Sacramento River. The Colusa Plains was noteworthy; with the exception of "The Willows," a small tree-abundant watering hole, the area was a vacant, windswept plain (Wagon Wheels 1956). Refuge lands consisted primarily of a dry alkaline plain, with fewer than 1,000 wetland and 4,800 deteriorated crop acres present. Beginning with the Civilian Conservation Corp's "Camp Sacramento" during the late 1930s, levees, water control structures, and delivery ditches were constructed to create and sustain wetlands across the majority of the Refuge.

Constructing delivery ditches at Sacramento Refuge (1938)
USFWS Photo

Today, the Refuge is known as the Sacramento National Wildlife Refuge, and it functions as the headquarters for the entire Complex. The Refuge is currently 10,819 acres (Figure 1) and is comprised of approximately 7,086 acres of managed wetlands (summer wetlands and seasonally flooded wetlands) and 3,360 acres of unmanaged wetlands, grasslands, alkali meadows, vernal pools, and riparian habitats. While most of these habitats no longer reflect the original landscape, management programs do attempt to mimic the natural conditions that once occurred throughout the Sacramento Valley on a much grander scale.

Wintering waterfowl have become increasingly dependent on these artificially created and maintained habitats because 90 to 95 percent of California's wetland habitat is gone, its water supply is highly regulated, and its human population is increasing with many associated impacts. As a result, the Service must now intensively manage the Refuge in order to provide a consistent quantity and quality of habitats to compensate for habitat losses due to agricultural and urban development. Many types of species benefit from these efforts, including those which are rare and abundant, resident and migratory, and game and non-game.

The Refuge currently supports approximately 250 species of birds; most notable are the huge wintering concentrations (November - January) of 500,000 to 750,000 ducks and 200,000 geese. This is quite a change, as historically the area supported many more geese than ducks, but the advent of rice culture in the early 1900s helped shift the balance. Raptor numbers swell as the waterfowl numbers increase, including bald eagles and peregrine falcons. In addition, shorebird numbers peak in the spring, while some waterfowl and numerous migratory songbird species nest here during the summer.

The Refuge is also home to numerous rare, threatened or endangered species, of which eight are federally listed; many of these are associated with a special type of wetland called vernal pools. The

alkali meadow and vernal pool habitats on the Refuge represent some of the largest remaining areas of this habitat type in California.

The visitor center is located in the Refuge headquarters office. Refuge staff is available to help plan a visit, answer questions and assist visitors. Visitors can experience a wildlife diorama and discovery room, and browse at our bookstore. Recreation activities on the Refuge include hunting, wildlife observation, photography, environmental education, and interpretation. There is a six-mile auto tour with an interpretive radio broadcast and a two-mile walking trail, which are open year-round. A multi-level viewing platform on the auto tour gives a panoramic view of the Sacramento Valley and provides visitors with opportunities to observe wildlife from among the treetops. Two photography blinds are available by advance reservation. Hunting of waterfowl, coot, common moorhen, snipe, and pheasant is permitted on the southern portion of the Refuge on Saturdays, Sundays, and Wednesdays during the legal seasons. The hunt program is cooperatively managed with the California Department of Fish and Game (CDFG) and offers spaced blind, assigned pond, and free roam hunting opportunities via a permit system.

8. Delevan National Wildlife Refuge

The Delevan Refuge was authorized in 1962 by the Migratory Bird Conservation Commission, and purchased with funds made available by the Migratory Bird Hunting and Conservation Stamp Act. The Refuge was established to provide sanctuary for migratory birds. The Refuge was formed by the purchase of two parcels, the 5,314-acre Charles W. Welch Ranch in 1962 and 320 acres belonging to Jesse Iverson in 1963. In 1991, the 80-acre Rennick property was transferred from the Farmers Home Administration and is now managed as part of Delevan Refuge. The last 163-acre parcel was purchased from Florence Watt Trust in 1994 under the authority of the Migratory Bird Conservation Act.

Similar to Sacramento Refuge, Delevan Refuge was created on an open plain of short grasses, shrubs, and forbs known as the Colusa Plains. This area has a gradual slope toward the Sacramento River to the southeast. Much of the land was flooded during the winter, and at one time there were even two lakes (Twin Lakes Gun Club) on the Refuge area. These historic flood patterns continue today as a major drain for the western Sacramento Valley, the Colusa Basin Drain (2047). The Colusa Basin Drain runs along much of Delevan's eastern boundary, often resulting in significant annual flooding of the Refuge from December through February.

Today, the Refuge consists of 5,877 acres (including the 80-acre Rennick property) (Figure 1). It is comprised of a combination of approximately 4,600 acres of managed wetlands (summer wetlands and seasonally flooded wetlands) and approximately 984 acres of

unmanaged wetlands, grasslands, alkali meadows, vernal pools, and riparian habitats. An endemic plant species, palmate-bracted bird's-beak is of particular interest in the alkali meadows. Listed as endangered on both Federal and State lists, Delevan Refuge is home to the largest remaining population, with an average annual population of 150,000 to 200,000 plants.

Palmate-bracted bird's-beak
Photo by Joe Silveria

Waterfowl numbers peak at nearly 415,000 ducks and over 150,000 geese. The tule white-fronted goose is especially important as their Pacific Flyway population is small and a significant portion of the population utilizes this Refuge during the fall and winter months. The Refuge also supports significant breeding colonies of tricolored blackbirds.

Public recreation activities include wildlife observation and photography from perimeter roads. Hunting of waterfowl, coot, common moorhen, snipe, and pheasant is permitted on the southern portion of the Refuge on Saturdays, Sundays, and Wednesdays during the legal seasons. The cooperatively managed hunt program with the CDFG offers spaced hunt site, assigned pond, and free roam hunting opportunities via a permit system.

9. Colusa National Wildlife Refuge

On December 5, 1944, the Migratory Bird Conservation Commission approved the purchase of the W.H. O'Hair tract containing 2,384 acres to create the Colusa Refuge. The purchase was made in 1945 with funds made available by the Migratory Bird Hunting and Conservation Stamp Act.

On May 18, 1948, an Act of Congress (16 U.S.C. 695-695c, otherwise known as the Lea Act) made provisions to fund, acquire, and maintain wildlife management and control areas in the State of California. The Lea Act targeted the problem of agricultural depredation and funds were available for "the construction of dams, dikes, ditches, buildings, and other necessary improvements and for the purchase, planting,

growing, and harvesting of grains and other crops for the feeding of waterfowl and other wildlife frequenting the localities where such lands may be purchased or rented." It also included provisions to permit hunting.

By the authority, purpose, and funding under the Lea Act, additional land was acquired for Colusa Refuge. On February 21, 1949, three tracts of land (760 acres) belonging to Libbie Jacobson were approved for purchase and acquired by the Refuge. Also under the provisions of the Lea Act, the 337-acre Wallace R. Lynn tract, the 480-acre Charles L. Stone tract, and the 80-acre Joseph T. Garibaldi tract were approved for purchase on April 27, 1949, February 19, 1952, and March 27, 1952 respectively.

The Refuge was established to provide sanctuary for migratory birds and to alleviate crop depredation. Today, depredation problems have decreased in magnitude due in part to reduced numbers of waterfowl, changes in agricultural practices, and increases in wetland quality and quantity.

From 1996 to 2002, an additional 646 acres were acquired under North Central Valley Wildlife Management Area, and are managed as part of the Refuge. Included in the 646 acres is a 448-acre parcel located south of Abel Road and west of Ohm road that was acquired in 1995, a 19-acre tract acquired in 1996, a 119-acre acquired in 2002, and a 60-acre parcel acquired in 2006.

Today the Refuge consists of over 4,686 acres, which includes the 646 acres acquired via North Central Valley Wildlife Management Area (Figure 1). It is comprised of approximately 3,347 acres of managed wetlands (summer wetlands and seasonally flooded wetlands) and approximately 1,191 acres of unmanaged wetlands, grasslands, alkali meadows, vernal pools, and riparian habitats. The Refuge lies in the Colusa Basin and is bisected by the Colusa Basin Drain, which drains the Basin southeast to the Sacramento River. The low topography and presence of the Colusa Basin Drain makes Refuge lands subject to regular winter flooding.

Currently, peak numbers of waterfowl can exceed 200,000 ducks and over 75,000 geese. In addition, significant numbers of giant garter snakes (Federal-listed threatened species) and palmate-bracted bird's-beak occur on the Refuge, as does the second largest acreage of vernal pools on the Complex.

Snow geese on Colusa Refuge
Photo by Mike Peters

Public recreation activities include wildlife observation and photography on a three-mile self-guided auto tour and a one-mile walking trail along a riparian slough and wetland. The auto tour and walking trail are open sunrise to sunset, year-round, with interpretive panels and pamphlets available at a kiosk. A photography blind is available by advanced reservation. Hunting of waterfowl, coot, common moorhen, snipe, and pheasant is permitted on the southern portion of the Refuge on Saturdays, Sundays, and Wednesdays during the legal seasons. The cooperatively managed hunt program with the CDFG offers both assigned pond and free roam hunting opportunities via a permit system.

10. Sutter National Wildlife Refuge

On December 5, 1944, the Migratory Bird Conservation Commission approved the purchase of the 306-acre S.G. Harris tract. This land was acquired on May 9, 1945, establishing the Refuge with funds made available by the Migratory Bird Hunting and Conservation Stamp Act. On December 5, 1944, approval was also given to purchase 141 acres from the State of California, 205 acres from the Sophie Davis Estates, and the 425-acre Grover C. Shannon tract. Funds provided for by the Lea Act were used to acquire 522 acres from Elizabeth P. Kilgarif in 1952 and 672 acres from the Sutter Home Investment Company in 1953. The last 231 acres was purchased from the State of California in 1956 with Lea Act funds.

The Refuge was established to provide sanctuary for migratory birds and alleviate crop depredation. Today, depredation problems have decreased due in part to reduced numbers of waterfowl, changes in agricultural practices, and increases in wetland quality and quantity.

Sutter Refuge is the only refuge in the Complex with privately-owned lands included within the approved acquisition boundary that have not been acquired (Figure 1). While there are no current plans to purchase these lands, the Service would consider it if the opportunity arises.

Sutter Refuge is located in the Sutter Basin between the Sacramento and Feather rivers (Figure 1). Historically, these rivers and Butte Creek flooded the Sutter Basin during the winter and spring. In the 1920s, the Sutter Bypass levees were constructed to channel these floodwaters. Over 80 percent of the Refuge lies within the northern portion of the Bypass and gradually slopes to the south. When floodwaters flow in the Bypass, the Refuge can be under at least 10 feet of water.

Sutter Refuge has 2,591 total acres, of which over 2,000 (approximately 80 percent) are located inside the Bypass. Habitat types, both inside and outside the Bypass, consist of approximately 1,881 acres of seasonal and summer wetlands and approximately 674 acres of unmanaged wetlands, grasslands, and riparian habitats.

Waterfowl numbers peak later than most other Refuges in the Complex (January – February) and include nearly 73,000 ducks and 100,000 geese. In addition, its border canals and associated riparian habitat ensure Sutter Refuge has one of the highest frequencies of yellow-billed cuckoos (Federal candidate species) in the Complex.

White-faced ibis
Photo by Mike Peters

Public recreation activities on the Refuge are limited to hunting of waterfowl, coot, common moorhen, snipe, and pheasant on the southern portion of the Refuge on Saturdays, Sundays, and Wednesdays during the legal seasons. The cooperatively managed hunt program with the CDFG consists of free roam hunting opportunities via a permit system.

11. Refuge Purposes

The Service acquires Refuge System lands under a variety of legislative acts and administrative orders. The official purpose or purposes for a refuge are specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, refuge unit, or refuge subunit. The Service defines the purpose of a refuge when it is established or when new land is added to an existing refuge. These purposes, along with the Refuge System mission, are the driving forces in developing refuge vision statements, goals, objectives and strategies in the CCP. The purposes also form the standard for determining if proposed refuge uses are compatible.

The Refuge purposes are:

11.1. Sacramento Refuge Purposes

"... as a refuge and breeding ground for migratory birds and other wildlife..." Executive Order 7562, February. 27, 1937.

"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." 16 U.S.C. ¤ 1534 (Endangered Species Act of 1973).

"... suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. 460k-1 "... the Secretary ... may accept and use ... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ..." 16 U.S.C. 460k-2 (Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended).

"... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. 742f(a)(4) "... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956).

11.2. Delevan Refuge Purpose

"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

11.3. Colusa Refuge Purposes

"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

"... for the management and control of migratory waterfowl and other wildlife ..." 16 U.S.C. 695 (Lea Act of 1948).

"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." 16 U.S.C. 1534 (Endangered Species Act of 1973).

11.4. Sutter Refuge Purposes

"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act of 1929).

"... for the management and control of migratory waterfowl and other wildlife ..." 16 U.S.C. 695 (Lea Act of 1948).

"... suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. 460k-1 "... the Secretary ... may accept and use ... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ..." 16 U.S.C. 460k-2 (Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended).

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12. The Refuges' Vision

A vision statement is developed for each refuge or complex as part of the CCP process. Vision statements are grounded in the unifying mission of the Refuge System. They describe the desired future conditions of the refuge unit in the long term (more than 15 years) and are based on the refuge's specific purposes, the resources present on the refuge, and any other relevant mandates. This CCP incorporates the following vision statement for the Sacramento, Delevan, Colusa, and Sutter Refuges.

> "Located in the Sacramento Valley of California, Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges are some of the most important wintering areas for waterfowl along the Pacific Flyway and in North America. The Refuges' wetland, vernal pool, alkali meadow, grassland, and riparian communities will provide high-quality habitat for a diverse array of wildlife species including migratory waterfowl, shorebirds, birds of prey, and songbirds. These habitats will also provide food, water, and cover for threatened and endangered species including vernal pool plants and invertebrates, and giant garter snakes.
>
> Working with partners, the Refuges will provide a wide range of environmental education programs and promote high quality wildlife-dependent recreation in order to maintain a refuge support base and attract new visitors. Compatible wildlife-dependent recreational opportunities for hunting, wildlife observation, photography, environmental education, and interpretation will be provided on the Refuges."

13. Existing and New Partnerships

In Fulfilling the Promise (USFWS 1999c), the Service identified the need to forge new and non-traditional alliances and strengthen existing partnerships with States, Tribes, non-profit organizations, and academia to broaden citizen and community understanding of and support for the Refuge System. The Service recognizes that strong citizen support benefits the Refuge System. Involving citizen groups in resource and management issues and decisions helps refuge managers gain an understanding of public concerns. Partners yield support for refuge activities and programs, raise funds for

projects, are activists on behalf of wildlife and the Refuge System, and provide support for important wildlife and natural resource issues.

A variety of people including, but not limited to, scientists, birders, hunters, farmers, outdoor enthusiasts and students are keenly interested in the management of Complex, its fish and wildlife species, and its plants and habitats. This interest is demonstrated by the number of visitors the Refuges receive and the partnerships that have already developed. We will continue to form new partnerships with interested organizations, local civic groups, community schools, Federal, State, and County governments, Tribes, and other civic organizations. Refuge partners include: California Department of Fish and Game, U.S. Bureau of Reclamation, U.S. Geological Survey, California Department of Water Resources, Glenn-Colusa Irrigation District, Ducks Unlimited, California Waterfowl Association, Altacal Audubon, California State University - Chico, Point Reyes Bird Observatory, California Rice Commission, Kiwanis Club, Rotary Club, and Butte Sink Waterfowlers Association.

14. Ecosystem Context

The Central Valley consists of four physiographic regions: the Sacramento Valley, the San Joaquin Valley, the Tulare Basin, and the Sacramento-San Joaquin Delta (Warner and Hendrix 1985). The Refuges are within the Service's Central Valley/San Francisco Bay Ecoregion (Figure 2).

The Complex can be put into an ecosystem context on many levels, including local, regional, national, international, or even global levels, on the variety and abundance of certain species and their habitats, extent of their range, or the geographic areas from or to which they migrate. Migratory birds come from breeding areas as far away as Siberia, Russia, Alaska, and the Canadian Arctic. Most spend the winter here, while others continue as far south as Central America to winter, only to pass through on their return trip in the spring. Seasonal wetlands and other habitats at the Complex provide essential food resources and resting areas for winter residents, birds continuing south, and returning spring migrants building up body reserves for their trip back to northern breeding areas.

The Central Valley of California supports the greatest number of wintering waterfowl in the Pacific Flyway and is, one of the most important wintering areas in North America (CVJV 2006). This level of importance can also be applied to shorebirds and other waterbirds, with several wetland areas in the Central Valley designated as those of international importance. The Sacramento Valley, specifically, is designated as a part of the Western Hemispheric Shorebird Reserve Network (WHSRN). Seasonal wetlands at the Complex play a significant role in supporting all migratory waterbird species in the Valley. In some cases, the Complex alone may support the majority of

the Pacific Flyway's wintering waterfowl. For example, in mid-October, 85 to 90 percent of the entire Pacific Flyway's greater white-fronted geese may be on the Complex (350,000-400,000 in some recent years). The Complex has had peak duck numbers of over 2,000,000 in years when California totals from mid-winter waterfowl surveys have been three to four million, as indexed by the Mid-winter Indices. While the Central Valley is also an important breeding area for mallards and several other species of waterfowl and shorebirds, these birds make up a relatively small percentage of the overall use of the Complex on an annual basis.

On a more local level, the Complex supports a variety of resident, migratory, and breeding wildlife species, native plants, and their habitats. Some are quite common, both in the Central Valley, the Flyway, and in North America. These would include a number of egret and heron species, white-faced ibis, black-tailed deer, and a variety of grassland and riparian birds. Other species are quite restricted in range. For example, the tricolored blackbird, yellow-billed magpie, and giant garter snake are species that occur almost exclusively in the Central Valley of California. In 2004, a single breeding colony of tricolored blackbirds on Delevan Refuge represented a significant proportion of the entire valley population and had the largest reproductive output of any colony of this species.

Yellow-billed magpie
Photo by Steve Emmons

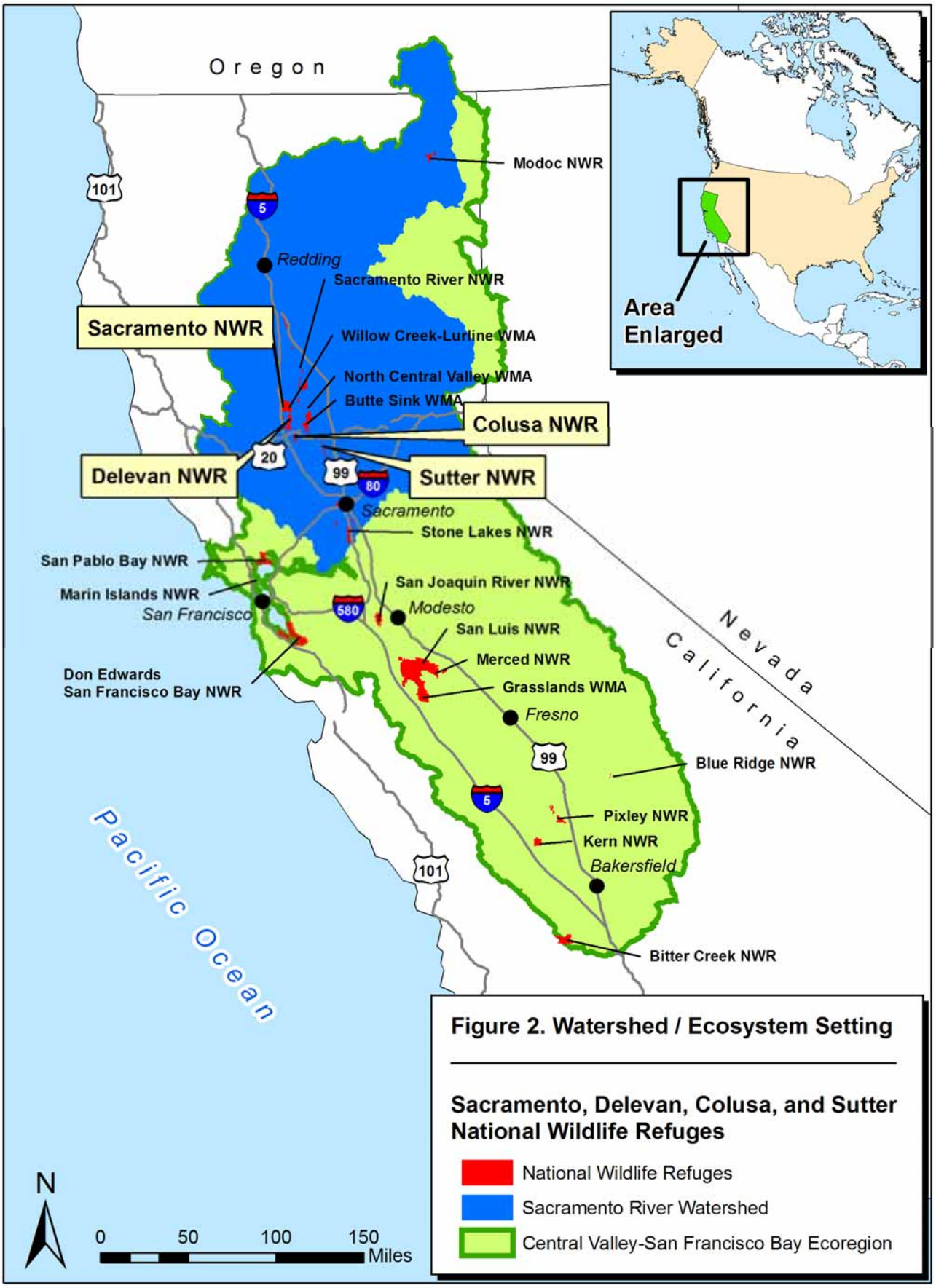


Figure 2. Watershed / Ecosystem Setting

Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges

Most of the alkali meadow, vernal pool, and short grassland habitats that once extensively occurred on the Sacramento Valley floor have been converted to agriculture or urban development. The Complex protects some of the largest remaining blocks of these habitats. As a result, the Complex supports a significant diversity and abundance of endemic plant and animal resources. In many cases species are rare, and in some cases, are listed as Federal and/or State endangered or threatened. There are seven threatened or endangered species that occur in vernal pool or alkali meadow habitats on the Complex, including three vernal pool invertebrates and four plants. The vast majority of the world's population of palmate-bracted bird's-beak, a rare Central Valley endemic and federally endangered plant, occurs on Delevan and Colusa Refuges. As habitat continues to dwindle with the expanse of urban development, areas such as the Complex become increasingly important to the conservation of these species. Appendix K provides a complete list of species, describes their migratory and breeding status at the Complex, and notes whether they are listed as endangered or threatened.

In summary, the Complex plays a significant, and in some cases, critical role at the ecosystem level. Its support of abundance, diversity, or single species conservation makes it critically important to conservation in general. Whether permanent or seasonal wetlands, vernal pools or alkali meadows, just protecting these habitats is not enough to maintain their function in the ecosystem. Without proper management, most of these habitats would be consumed by an ever-growing list of invasive species rendering them poor in both diversity and productivity (see Chapter 3, for current management).

15. Conservation Priorities and Initiatives

The Service is actively involved in the development and implementation of a number of conservation plans for migratory bird species, including the North American Waterfowl Management Plan (USFWS et al. 1986, 1998), Central Valley Joint Venture Implementation Plan (CVJV 2006), Partners in Flight North American Landbird Conservation Plan (Rich et al. 2004), Riparian Bird Conservation Plan (RHJV 2004), Draft Grassland Bird Conservation Plan (CPIF 2000), United States Shorebird Conservation Plan (Brown et al. 2001), Southern Pacific Coast Regional Shorebird Plan (Hickey et al. 2003), North American Waterbird Conservation Management Plan (Kushlan et al. 2002), Tri-colored Blackbird Status Update and Management Guidelines (Beedy and Hamilton 1997), Pacific Flyway Management Plan: Western Management Unit Mourning Dove (Pacific Flyway Council 2003), Anadromous Fish Restoration Program, and the California Wildlife Action Plan (CDFG 2005c). Regional step-down plans specific to the area are discussed in Appendix M.

16. Wilderness Review

As part of the CCP process, lands within the boundaries of the Sacramento, Delevan, Colusa, and Sutter Refuges were reviewed for wilderness suitability (Appendix O). No lands were found suitable for designation as Wilderness as defined in the Wilderness Act of 1964.

Sacramento, Delevan, Colusa, and Sutter Refuges do not contain 5,000 contiguous roadless acres, nor do the Refuges have any units of sufficient size to make their preservation practicable as Wilderness. The Refuges' lands have been substantially affected by humans, particularly through agriculture and urban development. As a result of the extensive modification of natural habitats and ongoing manipulation of natural processes, adopting a wilderness management approach for the Refuges would not facilitate the restoration of a pristine or pre-settlement condition, which is a goal of wilderness designation.

Pintails, snow and white-fronted geese at Sacramento Refuge (1941)
USFWS Photo

Chapter 2. The Planning Process

1. Introduction

This CCP for the Sacramento, Delevan, Colusa, and Sutter Refuges is intended to comply with the requirements of the Improvement Act and the NEPA. Refuge planning policy guided the process and development of the CCP, as outlined in Part 602, Chapters 1, 3, and 4 of the U.S. Fish and Wildlife Service Manual.

Service policy, the Improvement Act, and NEPA provide specific guidance for the planning process, such as seeking public involvement in the preparation of the EA. The development and analysis of "reasonable" management alternatives within the EA include a "no action" alternative that reflects current conditions and management strategies on the Refuges. Management alternatives were developed as part of this planning process and can be found in Appendix A: Environmental Assessment.

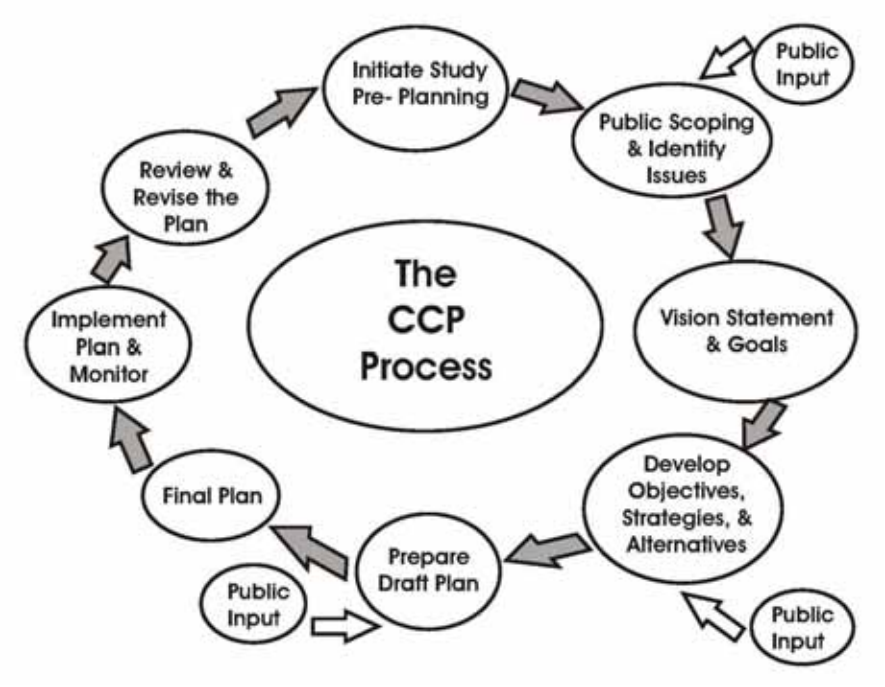
The planning process for this CCP began in February 2005 with pre-planning meetings and coordination. CCP teams were formed. Initially, members of the Refuge staff and planning team identified a preliminary list of issues, concerns, and opportunities that were derived from wildlife and habitat monitoring and field experience from the past management and history of the Refuges. Early in the process, visitor services, especially hunting, were identified as primary issues. This preliminary list was expanded during public scoping and then refined and finalized through the planning process to generate the vision, goals, objectives, and strategies for the Refuges.

2. The Planning Process

Part of comprehensive conservation planning includes preparation of a NEPA document. Key steps in the CCP planning process (Figure 3) and the parallel NEPA process include:

- Preplanning and Team formation
- Public Scoping
- Identifying issues, opportunities, and concerns
- Defining and revising vision statement and Refuge goals
- Developing and assessing alternatives
- Identifying the preferred alternative plan
- Draft CCP and EA
- Revising draft documents and releasing final CCP
- Implementing the CCP
- Monitoring / Feedback (Adaptive Management)

Figure 3. The CCP Process.



3. Planning Hierarchy

The Service planning hierarchy that determines the direction of the goals, objectives and strategies is a natural progression from the general to the specific (Figure 4). Described as a linear process, the planning hierarchy is, in reality, a multi-dimensional flow that is linked by the Refuge purposes, missions, laws, mandates, and other statutory requirements (Figure 5).

In practice, the process of developing vision, goals, and objectives is repetitive and dynamic. During the planning process, or as new information becomes available, the plan continues to develop.

Sora
Photo by Steve Emmons

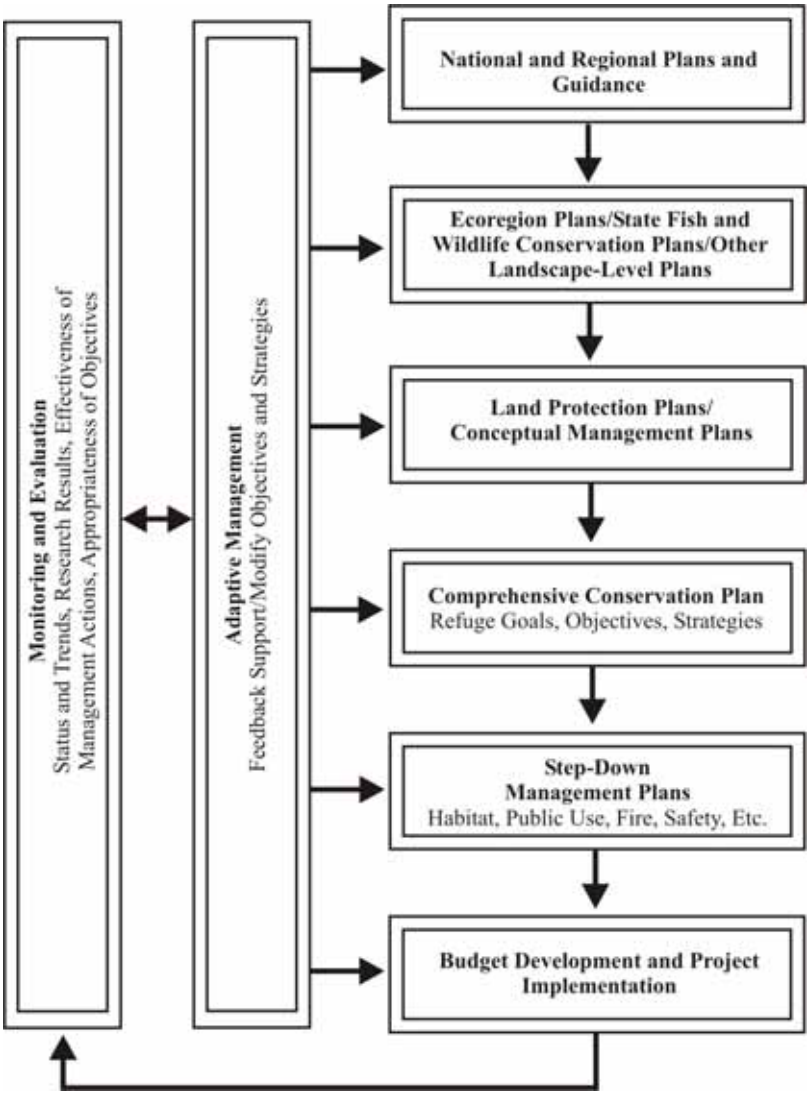
Figure 4. Hierarchical relationship of refuge goals and objectives to other aspects of the planning process.

Fish and Wildlife Service Mission
↓
Refuge System Mission
↓
Refuge Purpose(s)*
↓
National and Regional Goals and Priorities
↓
Ecosystem Goals and Objectives
↓
Refuge Vision
↓
Goals
↓
Objectives
↓
Strategies
↓
Monitoring and Feedback
(Adaptive Management)

(*When in conflict, we give priority to Refuge purpose(s) over the Refuge System mission.)

CCP scoping meeting in Yuba City, CA
Photo by Kipp Morrill

Figure 5. Relationships between Service and other planning efforts.



4. The Planning Team

The CCP process requires close teamwork with the staff, planners, and other partners to accomplish the necessary planning steps, tasks, and work to generate the CCP document and associated EA. The planning team is responsible for the CCP's content and will ensure that, when implemented it will achieve the purposes of the Refuges and help fulfill the Refuge System mission. Two teams were formed:

4.1. Core Team

The core team is responsible for the initiation and completion of all planning steps, including public involvement and NEPA. The members are responsible for researching and generating the contents of the CCP document and participate in the entire planning

process. The team consists of a refuge planner, refuge managers, biologists, and visitor services staff for the Complex (Appendix N). The core team meets regularly to discuss and work on the various steps and sections of the CCP. The team members also work independently in producing their respective CCP sections, based on their area of expertise. Multi-tasking by team members is a standard requirement since work on the CCP occurs in addition to their regular workload.

4.2. Expanded Team

The expanded team is the advisory and coordination forum of the CCP. It is significant for these Refuges because of the history of working in close partnership with other local, State, Federal, and private agencies and organizations concerned with the Refuges in the Complex. The expanded team is composed of the Core team, other Service and Federal personnel, and California Department of Fish and Game personnel who provide comments, discussion, and coordination during the planning process (Appendix N).

5. Pre-Planning

Pre-Planning involved forming the planning teams, developing the CCP schedule, and gathering data. The team determined procedures, work allocations, and outreach strategies. The team also created a preliminary mailing list.

6. Public Involvement in Planning

Public involvement is an important and necessary component of the planning process. Public scoping meetings allow the Service to provide updated information about the Refuge System and the Refuges. Most important, these meetings allow the refuge staff to hear public comments, concerns, and opportunities. These public meetings provide valuable discussions and identify important issues regarding the Refuge and the surrounding region.

The Service hosted public meetings in Willows, Colusa, and Yuba City, California in July 2005 (Table 1). Each meeting began with a presentation introducing the Refuges, provided an open forum for public comment, and ended with a breakout session consisting of various tables with refuge staff and information available to address questions regarding Refuge management, wildlife and habitat, and visitor services. In addition to comments made by participants and noted on flip charts at the meetings, comments were also received by written comment cards, email, faxes, and letters. These comments were analyzed and used to further identify Refuge issues and revise CCP goals, objectives, and strategies (Table 2).

Table 1. Public Scoping Meetings.

Meeting Date	Location	Attendance
July 6, 2005	Willows, CA	9
July 12, 2005	Colusa, CA	13
July 14, 2005	Yuba City, CA	13

Table 2. Refuge Issues Identified Through Public Comment.

Refuge Issue Category	Number of Comments Received [(1)]	Percentage of Total Comments
Visitor Services	**64**	**49%**
Hunting	55	40%
Fishing	3	2%
Environmental Education/Outreach	2	2%
Other Visitor Services	4	3%
Wildlife & Habitat	**21**	**16%**
Refuge Management	**22**	**17%**
Continue Current Management	3	2%
Water Supply	3	2%
Refuge Management	12	10%
LE/Fire	4	3%
Flooding Issues	**11**	**8%**
Other Comments	**13**	**10%**
Total Comments (Total Number of People/Organizations Commenting)	**131 (46)**	

[1] Total number of comments received is greater than the total number of people commenting since each of the letters, emails, faxes, comments cards, and flipchart comments received may contain more than one comment.

7. Public Outreach

During the planning process, Refuge staff continued to actively participate with the various working groups and agency teams concerning the Complex. The staff also met with several special interest and local groups to explain the planning process and to listen to their concerns.

An information letter called a "Planning Update" was also mailed to the public. These periodic publications were created to provide the public with up-to-date Refuge information and progress on the CCP process. The Planning Updates were also made available on the Complex's webpage, in the visitor center, and at various outreach meetings. The EA (Appendix A) contains a list of individuals and organizations that were notified or were sent a copy of the Draft CCP, were sent planning updates, or attended scoping meetings.

8. Issues, Concerns, and Opportunities

Through the scoping process and team discussions, the planning team identified issues, concerns, and opportunities. Thirty-five people attended the three public scoping sessions held in July 2005. Forty-six people/organizations provided 131 comments as of September 2005 (Table 2) for consideration in identifying issues and opportunities for the CCP. The team categorized the comments into five main areas of interest: visitor services, wildlife and habitat, refuge management, flooding issues, and other comments. Visitor services received the most comments (49 percent) followed by refuge management (17 percent), wildlife and habitat (16 percent), other comments (10 percent), and flooding issues (8 percent).

Of the sixty-four comments regarding visitor services, fifty-five were about hunting. Many of the hunting comments urged the Service to maximize the quantity and quality of hunting opportunities on the Refuges. Some of these comments were very specific regarding how the Refuges should change the hunting program, while others were more general. Two comments stated hunting should not be allowed on the Refuges and three stated fishing should be allowed on the Refuges. There were two comments about environmental education and outreach, and four about other visitor services.

The Refuge management category received twenty-two comments. Three comments suggested that the Refuges continue with their current management. Three comments expressed concern about water supply for the Refuges and two comments expressed the need for more law enforcement. One comment requested more prescribed burning on the Refuges; however, one comment stated that the prescribed burning program should be eliminated. Twelve other comments were made ranging from assessing the impacts of recreation on native flora and fauna to expanding the Refuges.

CCP scoping meeting in Yuba City, CA
Photo by Kipp Morrill

Twenty-one comments regarding wildlife and habitat issues were received. Several of the comments suggested increasing the waterfowl production on the Refuges by providing more breeding habitat in the closed areas. Several other comments expressed concern with the declining pheasant numbers both on and off of the Refuges. Several comments suggested leaving remnant stands of cover in treated management units.

Sutter Refuge was the focus of the eleven flood-related comments. Approximately 80 percent of the Refuge is located within the Sutter Bypass. Sutter Bypass was built in the 1920s and is a dedicated flood control channel. The concern expressed in the comments dealt with the management of the vegetation on the Refuge. There was apprehension that this vegetation may obstruct floodwater flows and provide a safety concern to properties in Sutter, Colusa, and Yolo counties.

The thirteen comments in the other comments category ranged from suggesting that the Sacramento River Conservation Area Forum landowner assurances policy be incorporated in the CCP to specific topics to be covered in the CCP. Several comments suggested referring to different plans and surveys for more information.

9. Development of the Refuge Vision

A vision statement is developed for each refuge or complex as part of the CCP process. Vision statements are grounded in the unifying mission of the Refuge System and describe the desired future conditions of the refuge unit in the long term (more than 15 years). They are based on the refuge's specific purposes, the resources present on the refuge, and any other relevant mandates. Please refer to Chapter 1 for the Refuges' vision statement.

10. Determining the Refuge Goals, Objectives, and Strategies

The purpose for creating the Refuges is established by law (Chapter 1, Section 11.1-11.4). The Improvement Act directs that the planning effort develop and revise the management focus of the Refuge within the Service's planning framework, which includes: the Service mission, the Refuge System mission, ecosystem guidelines, and refuge purposes. This is accomplished during the CCP process through the development of goals, objectives, and strategies.

10.1. Goals

The Service defines a goal as a "descriptive, open-ended, and often broad statement of desired future conditions that conveys a purpose, but does not define measurable units" (602 FW 1 of the Service Manual). Refuge goals are a means to achieving refuge purposes. Goals translate to one or more objectives that define these conditions in measurable terms. A well-written goal directs work toward achieving a refuge's vision and ultimately the purpose(s) of a refuge. Collectively, a set of goals is a framework within which to make decisions.

10.2. Interim Refuge Goals

The interim goals for Sacramento, Delevan, Colusa, and Sutter Refuges (from 1996 Interim Goals) are:

- Provide habitat for migratory birds, particularly waterfowl and other water birds.
- Provide habitat for and management of endangered, threatened, or species of special concern.
- Protect and provide habitat for Neotropical migratory birds.
- Preserve a natural diversity and abundance of flora and fauna.
- Provide opportunities for the understanding and appreciation of wildlife ecology and the human role in the environment and provide high-quality wildlife-dependent recreation and education.
- Conduct and direct compatible, management-oriented research.
- Alleviate crop depredation.

Through the CCP process these interim goals were evaluated and revised and are detailed in Chapter 4.

10.3. Objectives, Rationale, and Strategies

Once the Refuge goals are reviewed and revised then various objectives, a rationale, and strategies are determined to accomplish each of the goals.

Objectives: The Service defines objectives as "a concise statement of what we want to achieve, how much we want to achieve, when and where we want to achieve it, and who is responsible for the work" (602 FW 1 of the Service Manual). Objectives are incremental steps

we take to achieve a goal. They are derived from goals and provide a foundation for determining strategies, monitoring refuge accomplishments, and evaluating success. The number of objectives per goal will vary. Where there are many, an implementation schedule may be developed. All objectives must possess the following five properties: specific, measurable, achievable, results-oriented, and time-fixed.

Rationale: Each objective should document the rationale for forming the objective. The degree of documentation will vary, but at a minimum, it should include logic, assumptions, and sources of information. This promotes informed debate on the objective's merits, provides continuity in management through staff turnover, and allows reevaluation of the objective as new information becomes available.

Strategy: The Service defines a strategy as "a specific action, tool, technique, or combination of actions, tools, and techniques used to meet unit objectives" (602 FW 1 of the Service Manual). Multiple strategies can be used to support an objective.

Yellow warbler
Photo by Steve Emmons

11. Development of the Refuge Management Alternatives

Alternatives are "different sets of objectives and strategies or means of achieving refuge purposes and goals, helping to fulfill the Refuge System mission, and resolving issues" (602 FW 1 of the Service Manual). The development of alternatives, assessment of their environmental effects, and identification of the preferred management alternative are fully described in the EA (Appendix A). Alternatives were developed to represent reasonable options that address the specific Refuge issues and challenges. A "no action" or continuation of current management alternative is required by NEPA. A range of other alternatives was studied and are described in the EA (Appendix A). The alternatives are summarized below.

11.1. Alternative A: No Action

Under the Alternative A: No Action, the Refuges would continue to be managed as it has in the recent past. Recent management has followed existing step-down management plans:

- Annual Habitat Management Plans for Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges
- Fire Management Plan for Sacramento National Wildlife Refuge Complex
- Integrated Pest Management for Mosquito Control on Sacramento National Wildlife Refuge Complex
- Safety Plan
- Continuity of Operations Plan
- Hazardous Tree Removal Plan

The focus of the Refuges would remain the same: to provide habitat and maintain current active management practices and continue to manage and provide habitat for threatened and endangered species, migratory and resident birds, and other wildlife. The Refuges would continue to offer wildlife-dependant recreation opportunities including hunting, wildlife observation, photography, environmental education, and interpretation. Current staffing and funding levels would remain the same.

11.2. Alternative B: Emphasize Biological Resources

Under this alternative, the Refuges would emphasize management for biological resources. Biological opportunities would be maximized to allow optimum wildlife and habitat management throughout the majority of the Refuges. In addition, staffing and funding levels would need to be redirected and increased substantially to implement this alternative.

11.3. Alternative C: Proposed Action

Alternative C would achieve an optimal balance of biological resource objectives and visitor services opportunities. Habitat management and associated biological resource monitoring would be improved. Visitor service opportunities would focus on quality wildlife-

dependant recreation distributed throughout the Refuges. Staffing and funding levels would need to be increased to fully implement this alternative.

11.4. Alternative D: Emphasize Visitor Services

Under Alternative D, the Refuges would emphasize management for visitor services. Wildlife-dependant recreational opportunities would be expanded on the Refuges. However, staffing and funding levels would need to be redirected and increased substantially to implement this alternative.

12. Selection of the Proposed Action

The alternatives were analyzed in the EA (Appendix A) to determine their effects on the Refuges environment. Based on this analysis, the Service has selected Alternative C as the proposed action because it best achieves the Refuges goals and purposes, as well as Refuge System and Service missions.

Alternative C is founded upon the existing cooperative management programs, with enhancements in habitat and monitoring programs and an integration of a visitor services program that includes hunting, wildlife observation, photography, environmental education, and interpretation. Cooperative management refers to the current practice of working closely with State and other partners to provide protected and enhanced habitat along with visitor service opportunities on publicly owned properties. Please refer to Chapter 4, which describes this proposed management plan.

13. Plan Implementation

This Draft CCP and EA will be provided for public review and comment. Comments received by the Service will be incorporated where appropriate and perhaps result in modifications to the preferred alternative or selection of one of the other alternatives. The alternative that is ultimately selected will become the basis of the ensuing Final CCP. This document then becomes the basis for guiding management over the coming 15-year period. It will guide the development of more detailed step-down management plans for specific resource areas and will also underpin the annual budgeting process for refuge operations and maintenance (Chapter 5). Most importantly, it lays out the general approach to managing habitat, wildlife, and people at the Sacramento, Delevan, Colusa, and Sutter Refuges that will direct day-to-day decision-making and actions.

A review of the CCP will take place approximately every five years and the CCP will be updated every fifteen years.

Ash-throated flycatcher
Photo by Steve Emmons

Chapter 3. The Refuge Environment

1. Refuge Descriptions

1.1. Sacramento Refuge

Sacramento Refuge is the headquarters of the Complex and is located in the Sacramento Valley of north-central California. The Refuge is situated about 90 miles north of the metropolitan area of Sacramento and six miles south of the town of Willows, population 6,000. The Refuge consists of 10,819 acres in Glenn and Colusa counties.

The Refuge was established as a refuge for migratory birds and other wildlife. Major objectives are to: provide feeding and resting habitat for wintering waterfowl; provide habitat and manage for endangered, threatened, or sensitive species of concern; preserve a natural diversity and abundance of flora and fauna; provide an area for compatible, management-oriented research; alleviate crop depredation; and provide visitor service activities such as hunting, wildlife observation, photography, environmental education, and interpretation.

The Refuge is divided into approximately 117 management units, and managed wetlands comprise about 65 percent of the total acreage. They consist of summer wetlands (permanent and semi-permanent wetlands) and seasonally flooded wetlands (irrigated and non-irrigated seasonally flooded wetlands). The remaining acreage is comprised of unmanaged wetlands, alkali meadows, vernal pools, grasslands, riparian forests, and other habitats.

The wetlands of the Central Valley are critical to waterfowl of the Pacific Flyway (USFWS and Canadian Wildlife Service 1986). Currently, about 44 percent of the Pacific Flyway's waterfowl winters in the Sacramento Valley. The Refuge typically supports wintering waterfowl in excess of 680,000 ducks and 178,000 geese. As wetlands of the Central Valley have been lost, the waterfowl resource has become increasingly dependent upon the refuges of the Sacramento Valley. To help support the abundance of waterfowl and other wetland-dependent wildlife, the Complex's habitat management program is one of the most intensive in the Refuge System.

In addition to wintering waterfowl and associated resident, migratory and breeding wildlife species, habitats of the Sacramento Refuge support eight federally-listed threatened, endangered, or candidate species. Sacramento Refuge is identified as a core area, with the highest level of habitat protection–Priority 1–necessary for recovery of vernal pool plant and animal species (USFWS 2005a). This is not

surprising since some of the units at the Refuge form the largest, relatively intact remnants of vernal pool and vernal pool-alkali meadow complexes in the Colusa Basin. Priority 1 identifies localities or species, which represent the rarest species/genetics, most unique environmental/habitat conditions, and greatest threat of destruction (USFWS 2005a). Priority levels ensure that Federal, State and local agencies, which manage land, use their authorities to protect habitat and provide for the recovery and conservation of species identified in the recovery plan (USFWS 2005a). The recovery plan lists various conservation planning tools and programs, which minimize and avoid habitat loss, while others provide habitat and species occurrence conservation incentives (USFWS 2005a).

The visitor services program offers a six-mile auto tour; a two-mile walking trail; environmental education activities, presentations, guided tours, videos/DVDs, bookstore, and wildlife exhibits at the visitor center; interpretive kiosks with brochures; two photography blinds; teacher assistance; volunteer program; and waterfowl/pheasant hunting. The visitor center, six-mile auto tour route, two-mile walking trail, and two photo blinds accommodate more than 86,000 annual visits. Waterfowl, coot, common moorhen, snipe, and pheasant hunting are permitted on Saturdays, Sundays, and Wednesdays and account for about 7,600 visits annually.

1.2. Delevan Refuge

Delevan Refuge is situated about 80 miles north of the metropolitan area of Sacramento and four miles east of the town of Maxwell, population 1,500. The Refuge consists of 5,877 acres in Colusa County.

Delevan Refuge was established in 1962 as a refuge and breeding ground for migratory birds and other wildlife. Major objectives are to provide feeding and resting habitat for wintering waterfowl; provide habitat and manage for endangered, threatened, or sensitive species of concern; preserve a natural diversity and abundance of flora and fauna; alleviate crop depredation; and provide visitor service activities such as hunting and wildlife observation.

Delevan Refuge is divided into approximately 67 management units, and managed wetlands comprise about 78 percent of the total acreage. They consist of summer wetlands and seasonally flooded wetlands. The remaining acreage is comprised of unmanaged wetlands, alkali meadows, vernal pools, grasslands, riparian forest, and other habitats. The Refuge typically supports wintering waterfowl in excess of 415,000 ducks and 150,000 geese.

The Refuge supports one of the largest known populations of palmate-bracted birds-beak (Federal-listed endangered species) and significant breeding colonies of tricolored blackbirds. Some of the units on the Refuge form one of the largest relatively intact remnants

of the vernal pool and vernal pool-alkali meadow habitats that remain in the Colusa Basin.

A limited visitor services program offers wildlife observation and photography from adjacent county roads, including an undeveloped Watchable Wildlife site on Maxwell Road adjacent to the Refuge's south boundary. Waterfowl, coot, common moorhen, snipe, and pheasant hunting are permitted on Saturdays, Sundays, and Wednesdays and account for about 6,900 visits annually.

White geese flying
Photo by Mike Peters

1.3. Colusa Refuge

Colusa Refuge is situated about 70 miles north of the metropolitan area of Sacramento and one mile southwest of the town of Colusa, population 5,500. The Refuge consists of 4,686 acres in Colusa County.

Colusa Refuge was established in 1945 as a refuge and breeding ground for migratory birds and other wildlife and to reduce damage of agricultural crops caused by waterfowl. Major objectives are to provide feeding and resting habitat for wintering waterfowl; provide habitat and manage for endangered, threatened, or species of concern; preserve a natural diversity and abundance of flora and fauna; alleviate crop depredation; and provide visitor service activities such as hunting, wildlife observation, photography, environmental education, and interpretation.

Colusa Refuge is divided into approximately 59 management units, and managed wetlands comprise about 71 percent of the total acreage. They consist of summer wetlands and seasonally flooded wetlands. The remaining acreage is comprised of unmanaged wetlands, alkali meadows, vernal pools, grasslands, riparian, and other upland habitats. The Refuge typically supports wintering waterfowl in excess of 218,000 ducks and 113,500 geese.

The Refuge supports one of the largest known populations of giant garter snakes (Federal-listed threatened species) and palmate-bracted birds-beak (Federal-listed endangered species). Some of the units on the Refuge form one of the largest, relatively intact remnants of the vernal pool and vernal pool-alkali meadow habitats that remain in the Colusa Basin.

The visitor services program offers wildlife observation and photography from a three-mile auto tour route, one-mile walking trail, and one photography blind that supports 16,300 annual visits. Waterfowl, coot, common moorhen, snipe, and pheasant hunting are permitted on Saturdays, Sundays, and Wednesdays and account for about 3,700 visits per year.

1.4. Sutter Refuge

Sutter Refuge is situated about 50 miles north of the metropolitan area of Sacramento, 10 miles southwest of Yuba City, population approximately 60,000, and five miles south of Sutter, population approximately 2,900. The Refuge consists of 2,591 acres in Sutter County.

The majority of the Refuge is located within the Sutter Bypass of the Sacramento River Flood Control Project; an area dedicated to flood water conveyance. The eastern levee of the Sutter Bypass is managed by the Department of Water Resources. The western levee is managed by Reclamation District 1660. Both levees are part of the Sutter Bypass Wildlife Area managed by the California Department of Fish and Game (CDFG). The State of California Reclamation Board holds easements within the Bypass portion of the Refuge. The easements allow for the flow of floodwaters over the land and the removal of vegetation that may be impeding floodwaters. Copies of the specific easements are available for review at the Refuge Headquarters.

Sutter Refuge was established in 1945 as a refuge and breeding ground for migratory birds and other wildlife and to reduce damage of agricultural crops caused by waterfowl. Major objectives are to: provide feeding and resting habitat for wintering waterfowl; provide habitat and manage for endangered, threatened, or species of concern; preserve a natural diversity and abundance of flora and fauna; alleviate crop depredation; and provide visitor service activities, such as hunting and wildlife observation.

Sutter Refuge is divided into approximately 27 management units, and managed wetlands comprise about 73 percent of the total acreage. They consist of summer wetlands and seasonally flooded wetlands. The giant garter snake (Federal-listed threatened species) occurs on the Refuge primarily in the portion outside the Bypass. In recent years, the Refuge has supported significant white-faced ibis

nesting colonies (5,000-15,000 birds). The Refuge typically supports wintering waterfowl in excess of 73,000 ducks and 100,000 geese.

The remaining acres are in unmanaged wetlands, grasslands, riparian forest, and other habitats. The riparian habitat provides habitat for a variety of migratory songbirds, including the western yellow-billed cuckoo (Federal candidate species, State-listed threatened species), nesting Swainson's hawks (State-listed species), and nesting rookeries for great blue herons and great egrets.

A limited visitor service program offers hunting for waterfowl, coot, common moorhen, snipe, and pheasant on Saturdays, Sundays, and Wednesdays and account for approximately 2,100 visits annually.

2. Geographic/Ecosystem Setting

In the 1850s and 1860s, the area southeast of Willows, west of Princeton, and north of Colusa (known as the Colusa Plains) was characterized by alkali soil and sparse vegetation (Hinds 1952). These areas were dry most of the year or sometimes for whole seasons, but during major floods, were inundated and formed shallow lakes. Before reclamation occurred along the river, about 60 percent of the Sacramento Valley was subject to overflow, including basins, river lands, and a considerable portion of the low plains. The alkali plain was dotted with vernal pools and lakes of all sizes. These natural intermittent wetlands provided feeding and roosting habitat for many waterfowl.

Except for a few willow trees at a watering hole near "the Willows," the area was characterized as an open, wind-swept, alkali plain that presented an almost unbearable combination of summer heat and drought and unpredictable winter flooding.

Constructing delivery ditches at Sacramento Refuge (1938)
USFWS Photo

Winter wheat was introduced to the plains in the 1870s. Native pasture and winter wheat provided prime winter and early spring forage habitat for hundreds of thousands of small Canada geese. These early farmers employed "goose herders" to haze geese off their lands and keep them from devastating crops. The development of irrigation systems brought rice agriculture to the Sacramento Valley in the 1910s. Artesian wells were dug and surface water was diverted from the Sacramento River. The conversion to rice attracted an additional abundance of waterfowl to the plains and also resulted in

increased numbers in late summer and fall months. Coastal wetland loss during the same period likely contributed to this shift. Ducks were especially problematic for rice farmers, as they fed in the fields by the hundreds of thousands just prior to the harvest. Early migrating ducks, especially pintails, would often flatten and eat up to 40 acres of rice in a single night (Neff et al. 1943).

The United States government purchased the Spalding Ranch in 1937 because it was "the most famous goose sanctuary on the West Coast." Sacramento Refuge was established to manage land and provide lure crops for ducks that depredated neighboring rice fields. The Civilian Conservation Corps established Camp Sacramento at the Refuge in 1937 and began wetland habitat construction that remains an important feature of refuge management today (Hall 1975).

2.1. The Sacramento Valley Ecosystem

The Sacramento Valley forms the northern portion of the Great Central Valley, also referred to as the Central Valley, a 400-mile elongated depression that lies between the Coast Ranges and the Sierra Nevada (Figure 2). The Central Valley is actually two large valleys lying end to end, each drained by a major river. The Sacramento Valley is drained southward by the Sacramento River and the San Joaquin Valley, which forms the southern portion of the Central Valley, is drained northward by the San Joaquin River. The confluence of these two rivers occurs in the Delta area, east of San Francisco Bay.

In its pristine state, the Central Valley was characterized by over 25 plant communities providing habitats for a great diversity of plants and animals. These communities consisted of various riparian scrubs, forests, woodlands and savannas; perennial grasslands; annual wildflower fields; interior dune lands; vernal pools; alkali sinks, meadows, and scrubs; and fresh and brackish water marshes. Central Valley vegetation and habitats have been altered by human activity more than any other geomorphic province. In 1987, a report for the California Senate (Airola and Messick 1987) depicted that the valley grassland community is more than 99 percent gone, the freshwater marsh community is more than 94 percent gone, and the riparian woodland is about 89 percent gone. Approximately 75 percent of all vernal pools in the Central Valley were lost by 1997 (Holland 1998). Early losses were primarily related to conversion to agriculture croplands. More recent losses have been a result of conversion of historic cattle grazing lands to other uses and widespread urbanization (USFWS 2005a).

Non-native invasive species now dominate many natural vegetation types and wildlife habitats throughout the Central Valley. Agricultural developments, urban expansion, alteration of hydrologic regimes and channelization, and introduced plants and animals have

all contributed to the destruction of native habitats (Gilmer et al.1982, Katibah 1984).

In the Central Valley, about 250,000 acres of managed wetlands remain, about a third of which are publicly owned. Two-thirds are privately owned, mostly waterfowl hunting clubs. About 108,000 acres of riparian habitat remain, much of it fragmented (CVJV 2006). A major portion of the remaining vernal pool habitat is also privately owned.

Despite the huge loss of wetlands, much of the agricultural conversion around the Refuges and in the Sacramento Valley has been to rice. While not as productive or diverse as natural or managed wetlands, rice is generally wildlife-friendly relative to many other crop types (i.e. cotton or other row crops). Waste grain and other prey items in rice fields play a major role in the carrying capacity of current waterfowl and other waterbirds in the Central Valley (CVJV 2006). There is about 500,000 acres of rice in the Central Valley; most of it is in the Sacramento Valley and currently, about 70 percent is purposely flooded during winter months for stubble management and waterfowl hunting (CVJV 2006). Migratory birds and a number of other wildlife commonly spend time both on Refuges and nearby privately owned rice fields, often on a daily basis.

3. Physical Environment

3.1. Climate and Air Quality

The climate of California's northern Central Valley is classified as Mediterranean, with cool, wet winters and hot, dry summers. The annual average precipitation is 16-18 inches. Heavy fog is common during the winter months, while thunderstorms, hail, and snow are rare occurrences. The mean annual temperature is 61.7°F with extremes of 118°F and 15°F. The south winds are associated with storms in the winter and cooling trends in the summer. North winds are usually dry following winter storms, and hot and dry in the summer.

The Refuges are in California's Sacramento Valley Air Basin. The Sacramento Valley Air Basin encompasses 15,043 square miles including Butte, Colusa, Glenn, Sacramento, Shasta, Sutter, Tehama, Yolo, and Yuba counties, the western urbanized portion of Placer County, and the eastern portion of Solano County. The Glenn County Air Pollution Control District, Colusa County Air Pollution Control District, and the Sutter County Air Pollution Control District are the agencies responsible for ensuring compliance with Federal and State air quality standards in the basin where the Refuges are located.

The Federal and State governments have each established ambient air quality standards for several pollutants. Most standards have been set to protect public health. However, standards for some

pollutants are based on other values, such as protecting crops and materials, and avoiding nuisance conditions. Currently, Sutter County is federally classified as a non-attainment area for ground-level ozone. A non-attainment area is defined as any area that does not meet ambient air quality standards for a pollutant. In addition, Glenn, Colusa, and Sutter counties are classified by the State of California as non-attainment areas for ozone and particulate matter at the 10-micron level or smaller (PM10) standards. In fact, only three counties in the entire State are not classified as non-attainment areas for PM10. Classification as a non-attainment area means that the State must develop an implementation plan to outline methods for reaching identified air quality standards. Permitting, scheduling, and restrictions on some activities may be required. Currently, individual counties require smoke management plans and limit acreage burned on prescribed burns conducted by the Complex.

Red-tailed hawk
Photo by Steve Emmons

Ozone, the main component of photochemical smog, is formed through a complex series of chemical reactions between reactive organic gasses (ROG) and nitrogen oxides (NOx). On-road motor vehicles and other mobile sources are the largest contributors to NOx emissions in the Sacramento Valley. On-road motor vehicles, area-wide sources, and stationary sources are significant contributors to ROG emissions. Once formed, ozone remains in the atmosphere for 1 or 2 days. As a result, ozone is a regional pollutant and often impacts a large area. Ozone's main effects include damage to vegetation, chemical deterioration of various materials, and irritation and damage to the human respiratory system.

PM10 is produced by stationary point sources such as fuel combustion and industrial processes; fugitive sources, such as roadway dust from paved and unpaved roads; wind erosion from open land; and transportation sources, such as automobiles. The primary sources of PM10 in the Sacramento Valley are fugitive dust from paved and unpaved roads and agricultural operations, and smoke from residential wood combustion and seasonal agricultural burning. Soil type and soil moisture content are important factors in PM10 emissions. Federal and State PM10 standards are designed to prevent respiratory disease and protect visibility.

Certain land uses are considered more sensitive to air pollution than others. Locations, such as schools, hospitals, and convalescent homes, are labeled sensitive receptors because their occupants are more susceptible to respiratory infections and other air quality-related

health problems than the general public. Residential areas are also considered to be sensitive receptors because residents tend to be home for extended periods of time, resulting in sustained exposure to any pollutants present.

3.2. Water Supply

There are two main water sources used to manage the Sacramento, Delevan, Colusa, and Sutter Refuges' wetland habitat base. The majority of the water used throughout the year is delivered from the Sacramento River from the Bureau of Reclamation's (BOR) Central Valley Project (CVP). In addition, there are some riparian water rights that allow a refuge to divert specific amounts of water from creeks and tributaries during certain times of the year. There has been very little use of ground water on the Refuges, other than domestic wells. All water sources depend largely upon gravity flow and are distributed and impounded via a series of delivery and drainage ditches, levees, and water control structures.

The water supply is probably best described in relation to the Central Valley Project Improvement Act (CVPIA), which instituted major changes to the Refuges' water supply.

In October of 1992, the CVPIA (Public Law 102-575) was passed into law. The purposes of the Act include addressing the impacts of the CVP on fish, wildlife and associated habitats. The Act directed that water, in amounts equal to the Level 2 and increasing to the Level 4 water supplies identified in the "Report on Refuge Water Supply Investigations," be made available year-round to refuges in California's Central Valley (BOR 1989). Level 2 is the firm water supply historically required for existing habitat management, while Level 4 is the increased amount of water needed for full habitat development. These amounts are described in Table 3. The increased volume between Level 2 and Level 4 supplies was to come from annual increases, in 10 percent increments, until Level 4 supplies were reached (CVPIA, Title 34 Public Law 102-575). While these water amounts are allotted by refuge and totaled by month, the Act allows for water redistribution both between months and among refuges, in order to respond to specific annual habitat management program needs.

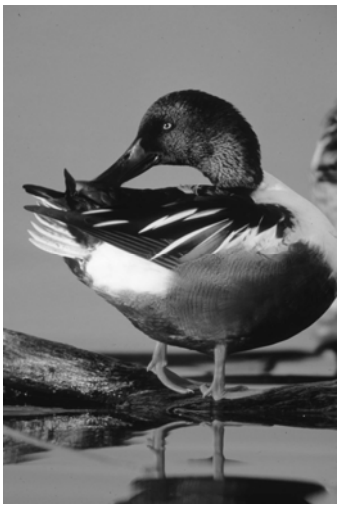
Table 3. CVPIA Water Supplies for each of the Refuges.

Refuge	Level 2 (acre feet)	With Level 4 (acre feet)
Sacramento	46,400	50,000
Delevan	21,950	30,000
Colusa	25,000	25,000
Sutter	23,500	30,000

3.2.1. Pre - CVPIA

Prior to October 1992, the Complex had no firm water supply. Water was provided to Sacramento, Delevan, and Colusa Refuges by BOR, via facilities of the Glenn-Colusa Irrigation District (GCID), on an "as available" basis. While most years saw adequate amounts delivered, the Refuges often suffered from lack of water availability from late November through early April, as GCID shut down for canal maintenance. Absent adequate rainfall, many Refuge wetlands would begin to go dry in early December. In the mid-1980's, BOR began construction of a cross-tie from Stony Creek to the Tehama-Colusa Canal to divert 80 cubic feet per second (cfs) to meet water contract demands from other irrigation districts. The Sacramento Refuge was promised utilization of any or all of this 80 cfs pending other current requests. The endangered listing of the winter-run Chinook salmon in the Sacramento River shut down any water deliveries via the Tehama-Colusa Canal, thereby eliminating any possibilities for winter water for the Refuges.

Additional problems involving endangered Chinook salmon existed at the point of water diversion. GCID diverts water from the Sacramento River via lift pumps near Hamilton City at a time when emigrating salmon fry could be impacted by an unscreened or poorly screened diversion. As a result, in the late 1980s and early 1990s, GCID completed extensive work to improve the efficiency of their fish screens at the Hamilton City pumping plant.



Northern shoveler
Photo by Mike Peters

On their return migration, adult salmon also encounter problems resulting from the redistributed nature of Valley water supplies derived from the Sacramento River. Salmon mistakenly enter the Colusa Basin Drain (2047) at its point of contact with the Sacramento River near Knights Landing, and proceed up the many tributaries in search of their spawning areas. As a result, each fall these "lost salmon" are observed in the Refuge portions of creeks and ditches that eventually lead to the Colusa Basin Drain.

Sacramento Refuge

Historically, the Sacramento Refuge had a contract with GCID for gravity flow delivery of up to 50,000 acre-feet of BOR CVP water. Allowing for a 20 percent conveyance loss, the actual amount of CVP water that was available to the Refuge was 37,000 acre-feet annually. In addition to this delivered water supply, the Sacramento Refuge

also had four appropriative licenses to divert a total of 60 cfs for irrigation and/or wildlife purposes on 4,575 acres. Two ground water wells were located along the northwest boundary, of which one continues to be available, if needed.

Delevan Refuge

Other than the gravity flow of delivered surface water, Delevan Refuge has no additional sources of water.

Colusa Refuge

Colusa Refuge utilized three lift pumps to secure GCID water from the Colusa Basin Drain, and one lift pump to utilize water delivered by GCID. In addition, the Refuge employed riparian licenses to supply up to 25-30 percent of the surface water used during an annual habitat management cycle. One groundwater well, located along the west boundary at the northwest corner of Tract 10, was used sparingly to supplement the water supply in the main canal.

Sutter Refuge

The Refuge has two appropriative licenses to divert water for irrigation and wetland purposes. They allowed diversion of 25 cfs and 5 cfs from the east Bypass channel and the water was utilized to supply habitat needs on Refuge lands inside the Sutter Bypass.

Approximately 335 acres of wetland habitat is located outside of the Sutter Bypass. An agreement with the Sutter Extension Water District provided water for this area via gravity and a low-lift pump adjacent to Tract 20.

3.2.2. Post - CVPIA

Many of the uncertainties related to the water supply for Sacramento, Delevan, and Colusa Refuges were eliminated with the authorization of the CVPIA. Not only was a firm water supply created, the annual Level 2 allotments can not be decreased by more than 25 percent, even during drought (“critically dry”) years. In addition, the Act required BOR to pay for the water, deliver it to the Refuge boundary, and the water was to be made available year-round. In order to accomplish this, BOR entered into a long-term contract with GCID for water delivery to Sacramento, Delevan, and Colusa Refuges.

Each year the Complex provides BOR with the anticipated water needs. Since CVPIA’s authorization, only Level 2 water has been used on Sacramento and Colusa Refuges. On Delevan Refuge, some Level 4 water has been required to meet habitat management objectives. Based on experience, the Refuges continued to modify the amount, timing, and delivery points of anticipated water needs. To date, no CVPIA water has been delivered to Sutter Refuge, primarily due to the lack of a means for conveyance.

Sutter Refuge uses 1933 Funds (CVPIA) to pay for all water and pumping expenses annually (approximately $10,000 for 335 acres).

In order to implement CVPIA, many improvements have been made, including modifications to GCID facilities that allowed year-round Refuge water delivery to begin in 2000.

A series of meters were installed on all three Refuges to measure the amounts of water delivered.

As required by the CVPIA, Water Management Plans were completed for Sacramento, Delevan, and Colusa Refuges in 2005 (Appendix I). These five-year plans document water use, identify water supply system needs, and outline steps required to improve both the efficiency and quantity of water used.

3.3. Contaminants and Water Quality

As environmental awareness grew, impacts to water quality became a major focus throughout the United States. In California, probably nowhere was this more evident than in the San Joaquin Valley, especially with selenium concerns at Kesterson Refuge.

Pied-billed grebe and chick
Photo by Mike Peters

In the Sacramento Valley, due to the lack of a secure water supply, Refuges often utilized drain water from surrounding agricultural and urban lands to flood and maintain wetland habitats. Even delivered water from local irrigation districts had often previously been used "upstream," most commonly for growing rice.

The California Department of Fish and Game (CDFG) initiated a selenium verification study in 1985 (White et al. 1987). They concluded that selenium concentrations in water and fish occurred at less than harmful levels in the Sacramento Valley. Fish kills in the Colusa Basin Drain during the early 1980's indicated high concentrations of molinate and the herbicide thiobencarb (associated with rice farming practices) in fish and water samples collected throughout the agricultural drains and in the Sacramento River downstream of drain inflow. California's Department of Pesticide Regulation implemented the Rice Pesticide Program in 1983, which established performance goals for molinate and thiobencarb in 1990 and the insecticides methyl parathion and malathion beginning in 1991. County agricultural commissioners, with the use of restricted materials permits, implemented program requirements for molinate, thiobencarb, methyl parathion, and malathion in 2001.

Water quality and potential contaminants were also a concern on the Complex. To further address these concerns, a collaborative study was conducted by the U.S. Geological Survey, U.S. Fish and Wildlife Service, and U.S. Bureau of Reclamation entitled "Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota Associated with Irrigation Drainage in the Sacramento National Wildlife Refuge Complex, California, 1988-89" (Dileanis et al. 1992). The report concluded, "there is some degradation of water quality related to agricultural drainage in the region, and elevated concentrations of some chemical constituents were detected in water, sediment, and biological samples. These elevated concentrations were only slightly greater than Service guidelines for possible effects on wildlife." Of greatest interest were the DDT family of organochlorine compounds detected in all bottom-sediment samples from canals containing drain water; the DDE content of white-faced ibis and black-crowned night herons (Colusa Refuge); and the thiocarbamate herbicide molinate (rice field use) that was detected in all 21 samples (one exceeding the State of California guideline for the protection of aquatic habitat) timed to coincide with peak spring water releases.

In addition, a number of ground water wells, both those already in existence in the 1980s (especially at Sutter Refuge) and BOR exploratory test wells completed in the early 1990s (Sacramento Refuge), documented water contamination with arsenic, cadmium, mercury, and boron exceeding recommended limits.

Beginning in 2005 the Complex began membership/participation in two groups (Colusa Basin Subwatershed Program and Butte-Yuba-Sutter Water Quality Coalition) of the Sacramento Valley Water Quality Coalition. These groups provide water quality monitoring required by the Central Valley Regional Water Quality Control Board's Irrigated Lands Conditional Waiver Program. The program requires anyone owning lands that have irrigation return water and/or storm water runoff leaving their lands to complete water quality monitoring. To date, no water quality problems related to the Refuges have been documented.

Most recently, in early 2006, methyl mercury associated with seasonal wetlands has become an increased concern.

3.4. Geology, Hydrology, and Soils

The area between Willows and Knights Landing is underlain by sedimentary and volcanic deposits associated with the Tehama, Tuscan, Red Bluff, and Riverbank formations. On top of these formations lie younger fan deposits of the Modesto formation, as well as basin, marsh, and floodplain alluvial deposits associated with the Sacramento River and North Coast Range streams (Harwood and Helley 1982; Helley and Harwood 1985).

Sacramento, Delevan, and Colusa Refuges are located in the Colusa Basin. Over 75 percent of these Colusa Basin refuges occur on basin deposits. Here Refuge soils are located at the higher elevations of the basin (i.e., the basin rim) where they are predominately strongly saline-alkali Willows clay, Willows silty clay, and Riz silty clay loam (Begg 1968). These are wetland soils associated with a high water-table, and subjected to occasional to frequent flooding. A variety of salt-tolerant wetland plants naturally occur in this arid, alkali landscape. These soils are of limited agricultural productivity, supporting rice through the constant application of summer water, which translocates salts deep into the soil profile. Sutter Refuge soils mostly consist of basin floor deposits (i.e., marsh deposits) represented by Oswald clay, frequently flooded in the Bypass, and Oswald clay located outside the Bypass (Begg 1968; Lytle 1988; Reed 2006).

Several natural creeks and sloughs bisect the Colusa Basin refuges including Logan Creek and Hunter Creek on Sacramento Refuge; Stone Corral Creek and the Colusa Basin Drain at Delevan Refuge; and the Colusa Basin Drain and Powell Slough through Colusa Refuge. Numerous drains also bisect these Refuges, such as the Northeast Slough and East Slough (Delevan Refuge).

Sutter Refuge is located at the upper end of the Sutter Basin and lies mostly within the Sutter Bypass. This area of the Refuge was characterized as a large freshwater sink with a network of sloughs associated with the Sacramento River floodplain.

Prior to land reclamation and flood control, Colusa Basin refuges flooded at occasional to frequent intervals. Because of the refuges' Basin Rim location, flood waters quickly receded into the natural troughs and sloughs, these eventually drained into the Sacramento River or large freshwater sinks, such as in the Sutter Basin, where bulrushes (tules) and cattails formed massive impenetrable thickets of vegetation (Holmes et al. 1915). This once extensive marshland habitat supported abundant and diverse native fish and wildlife.

Most floodwater was off the Basin Rim during the growing season, resulting in a barren, alkali, and windswept plain (Silveira 2000, 2001). A relatively dense aggregation of large intermittent lakes, vernal pools, mima mounds, and alkali sinks and flats characterized the Colusa Basin (Holmes et al. 1915), and were historically known as the "Colusa Plains." These natural wetlands filled with winter rains, providing abundant waterfowl and shorebird habitat. In the springtime a vast parade of wildflowers of every color of the rainbow carpeted the Colusa Plains (Hanson 1944; Silveira 2000, 2001).

4. Habitat

4.1. Vegetation

The Refuges consist mostly of managed wetlands with much smaller amounts of unmanaged wetlands, vernal pools, alkali meadows, grasslands, riparian forest, and other habitats (Table 4).

The majority of wetlands are seasonally flooded with 10 to 15 percent managed as summer wetlands (Figures 6-9). A comprehensive list of plant species can be found in Appendix K. Descriptions of the habitats and their associated plant/wildlife species follows.

Table 4. Acreage and habitats of Sacramento National Refuge Complex.

	Acreage							
		Managed Wetlands[2]						
Refuge	Total[1]	Seasonally Flooded Wetlands[3]	Summer Wetlands[4]	Unmanaged Wetlands[2]	Vernal Pool/Alkali Meadow[2]	Grasslands[2, 5]	Riparian Forest[2,6]	Other[2,7]
Sacramento	10,819	6,305	781	163	2,941	139	117	373
Delevan	5,877[8]	3,939	661	13	461	464	46	290
Colusa	4,686[9]	2,957	390	119	619	438	15	148
Sutter	2,591	1,708	173	45	0	226	403	36
TOTAL	**23,973**	**14,909**	**2,005**	**340**	**4,021**	**1,267**	**581**	**847**

[1] Official refuge acres.
[2] Acres calculated with GIS from 2006-07 annual habitat management plans.
[3] Includes irrigated and non-irrigated seasonally-flooded wetlands.
[4] Includes semi-permanent and permanent wetlands.
[5] Includes annual and perennial grasslands
[6] Includes mixed riparian forest, cottonwood willow, willow scrub, and valley oak riparian forest.
[7] Includes roads, facilities, and other miscellaneous areas.
[8] Includes the 80-acre Rennick property.
[9] Includes 646 acres acquired under North Central Valley Wildlife Management Area.

Sacramento Refuge at sunrise
Photo by Steve Emmons

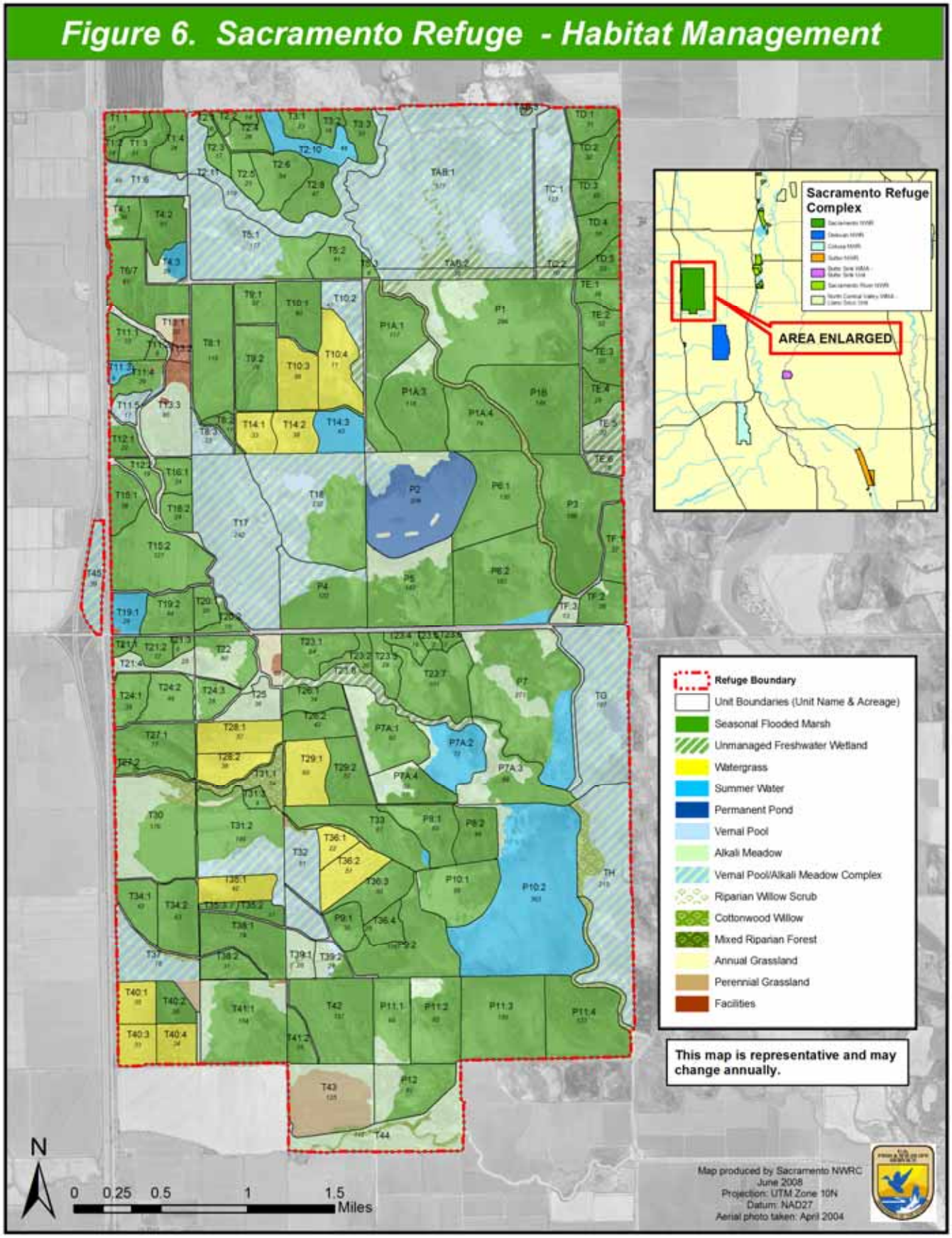


Figure 6. Sacramento Refuge - Habitat Management
Sacramento Refuge Complex
AREA ENLARGED
Refuge Boundary
Unit Boundaries (Unit Name & Acreage)
Seasonal Flooded Marsh
Unmanaged Freshwater Wetland
Watergrass
Summer Water
Permanent Pond
Vernal Pool
Alkali Meadow
Vernal Pool/Alkali Meadow Complex
Riparian Willow Scrub
Cottonwood Willow
Mixed Riparian Forest
Annual Grassland
Perennial Grassland
Facilities
This map is representative and may change annually.
N
0 0.25 0.5 1 1.5 Miles
Map produced by Sacramento NWRC
June 2008
Projection: UTM Zone 10N
Datum: NAD27
Aerial photo taken: April 2004

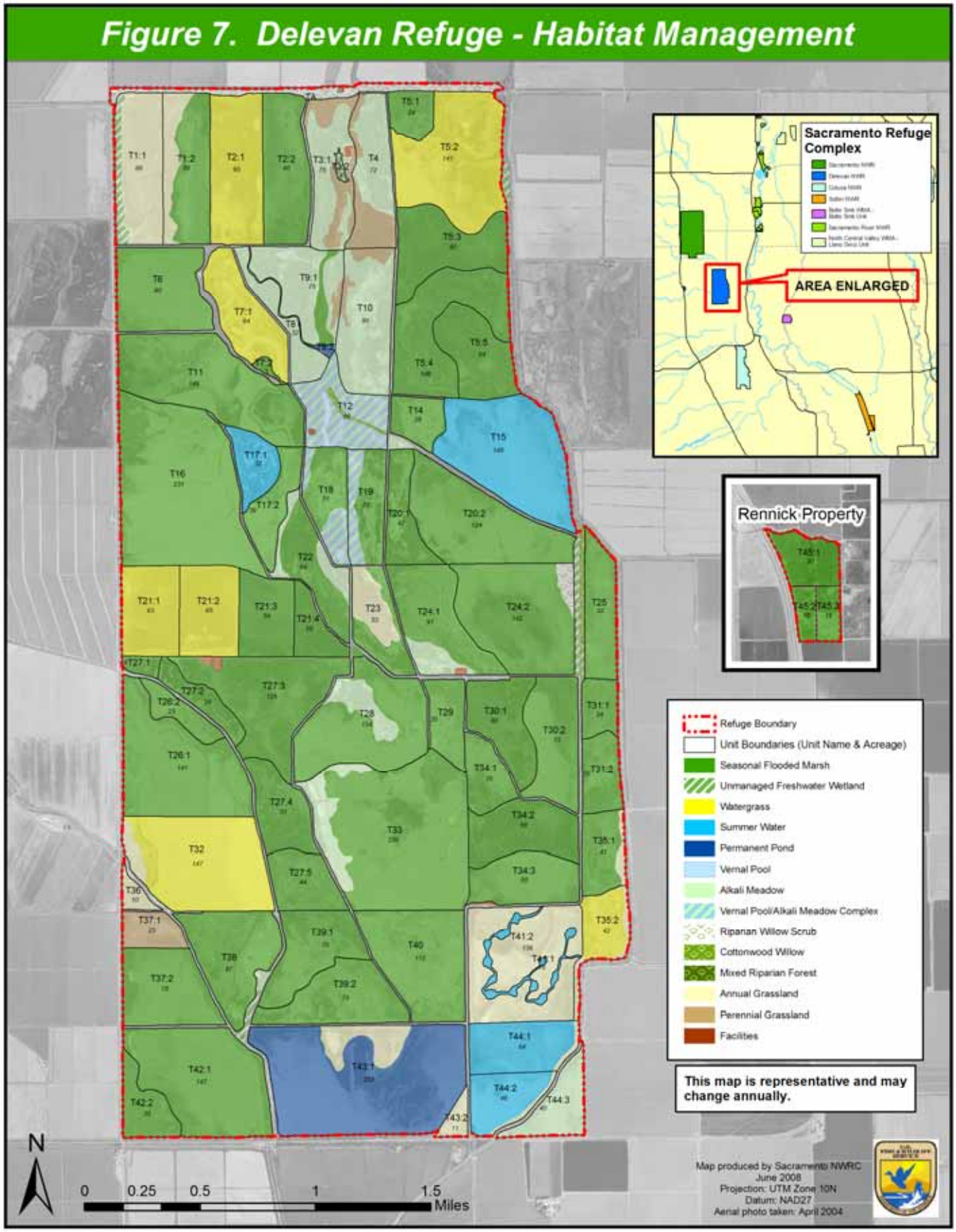


Figure 7. Delevan Refuge - Habitat Management
Sacramento Refuge Complex
AREA ENLARGED
Rennick Property
Refuge Boundary
Unit Boundaries (Unit Name & Acreage)
Seasonal Flooded Marsh
Unmanaged Freshwater Wetland
Watergrass
Summer Water
Permanent Pond
Vernal Pool
Alkali Meadow
Vernal Pool/Alkali Meadow Complex
Riparian Willow Scrub
Cottonwood Willow
Mixed Riparian Forest
Annual Grassland
Perennial Grassland
Facilities
This map is representative and may change annually.
N
0 0.25 0.5 1 1.5 Miles
Map produced by Sacramento NWRC
June 2008
Projection: UTM Zone 10N
Datum: NAD27
Aerial photo taken: April 2004

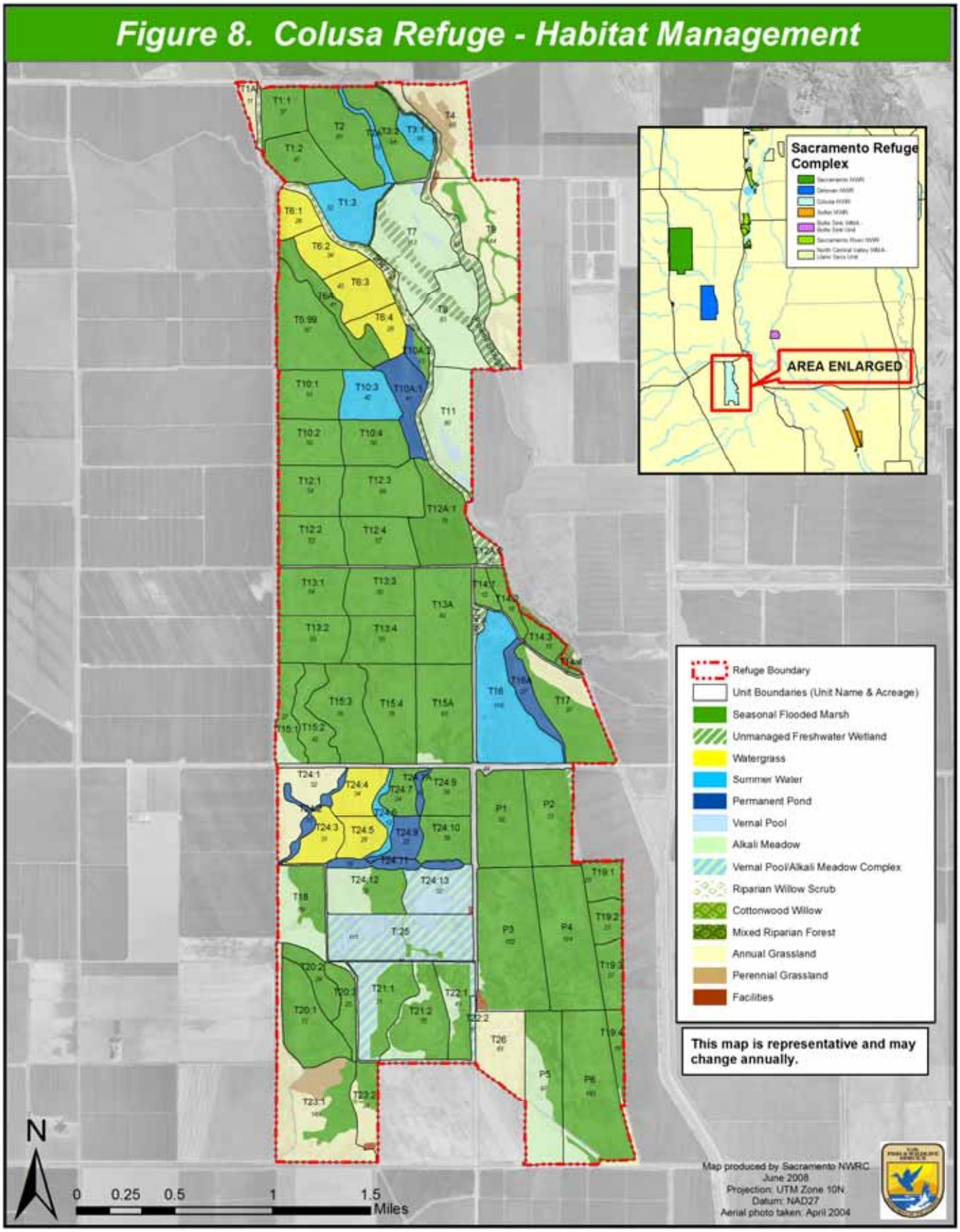
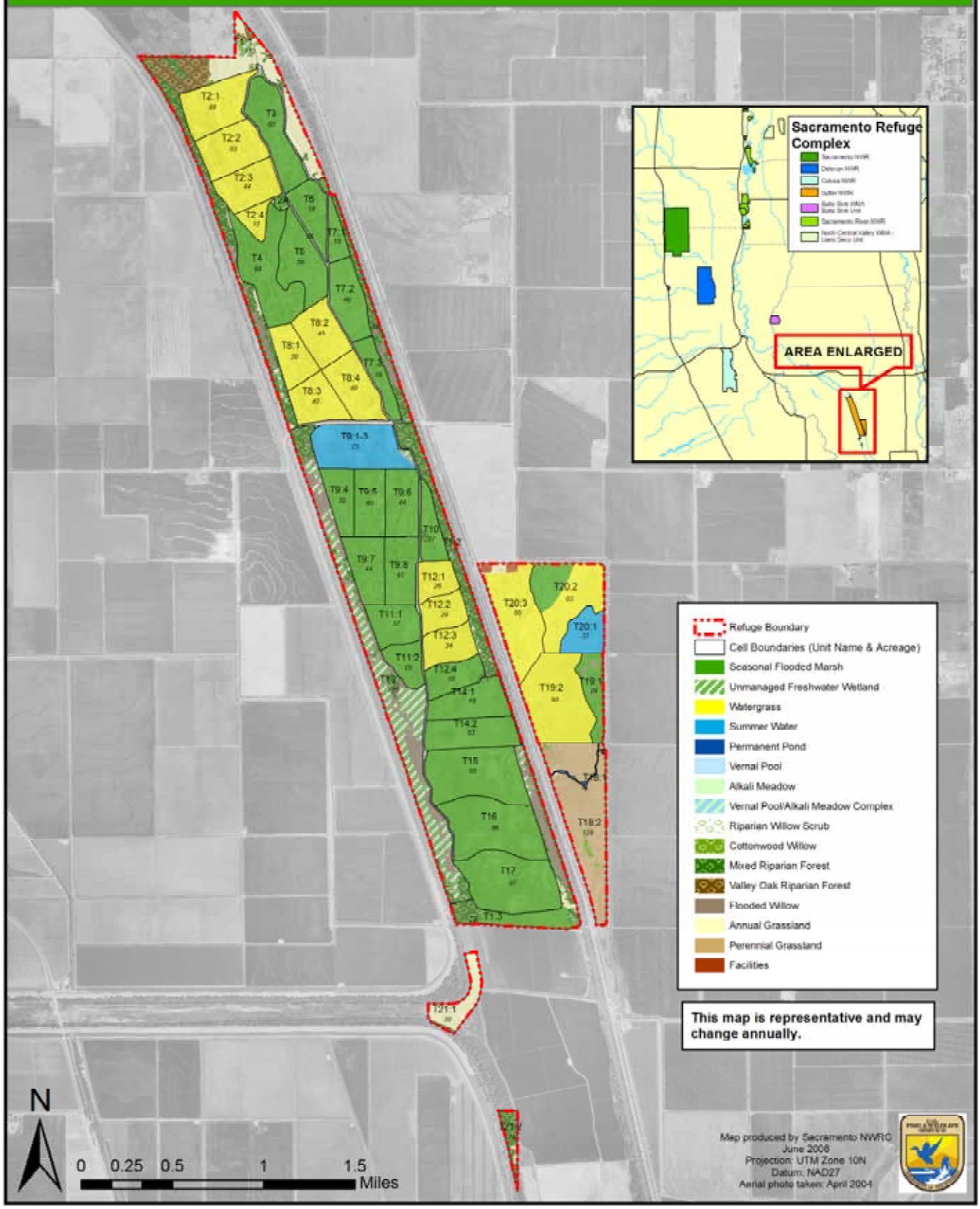


Figure 8. Colusa Refuge - Habitat Management
Sacramento Refuge Complex
AREA ENLARGED
Refuge Boundary
Unit Boundaries (Unit Name & Acreage)
Seasonal Flooded Marsh
Unmanaged Freshwater Wetland
Watergrass
Summer Water
Permanent Pond
Vernal Pool
Alkali Meadow
Vernal Pool/Alkali Meadow Complex
Riparian Willow Scrub
Cottonwood Willow
Mixed Riparian Forest
Annual Grassland
Perennial Grassland
Facilities
This map is representative and may change annually.
N
0 0.25 0.5 1 1.5 Miles
Map produced by Sacramento NWRC
June 2008
Projection: UTM Zone 10N
Datum: NAD27
Aerial photo taken: April 2004

Figure 9. Sutter Refuge - Habitat Management



4.2. Wetlands

The Central Valley has lost 90 to 95 percent of its original wetlands that existed in the late 1800s (Holland 1978; Gilmer et al. 1982; Frayer et al. 1989; Kempka and Kollasch 1990). Many of the original wetlands in the Sacramento Valley occurred along rivers and creeks, where over bank flooding seasonally inundated large expanses of wetlands during major rain events and runoff during the spring. In areas farther away, isolated vernal pools were also filled directly from precipitation, creating significant wetland landscapes.

Because of historic losses of wetlands, most of the remaining wetlands in the Sacramento Valley are intensively managed, including those on the Complex. They are managed to maximize resources to support the annual abundance of migratory birds, endangered and threatened species, and other wetland-dependent wildlife. This has been accomplished through creation and enhancement of "managed wetlands," while maintaining and restoring natural wetland habitats (vernal pools, vernal pool/alkali meadow complex, riparian scrub and forests), when appropriate (Mensik and Paveglio 2004). For the most part, managed wetlands are artificially created and maintained, with the majority having at least some perimeter and interior levees, water control structures, and water delivery and drainage canals. Most of the water used to flood these wetlands is delivered to Refuge boundaries via local irrigation districts. Much of the original infrastructure (water conveyance, levees, etc.) was constructed shortly after the Refuges were established. In other cases, agricultural fields (see section 4.5 Agricultural Croplands) provided some levees and water control structures that would eventually be modified to facilitate managing wetlands. Many of these fields were leveled over the years, with equipment of the era, to promote higher yields of crops and millet or watergrass. The last major field leveling occurred in the late 1970s, associated with the Bicentennial Land Heritage Program (BLHP) funding.

Ironically, in the 1980s, the trend was reversed and an era of deleveling was initiated to undo some of the leveling work that had been previously completed. Although leveled fields may have increased crop or millet yields, the resulting habitat was homogenous, lacking diversity in plant species, water depths, and ultimately wildlife. During the same period, cooperatively farmed rice agriculture on the Refuges was being phased out and wetland restoration on private lands was beginning largely on previously leveled rice fields. Techniques for deleveling rice fields to convert them to managed wetlands were developed (Strong et al. 1990) and have been modified for enhancing existing managed wetlands as well. This involves the creation of swales and potholes throughout the pond bottoms in order to establish a variety of water depths, vegetation types, and open water areas.

Although agriculture and managed wetlands have replaced much of the "plains" landscape in the Sacramento Valley, significant areas of vernal pool and alkali meadow habitat complexes and some remnant sloughs and ponds still occur on the Refuges. These areas exist as "natural" (or unmanaged) wetlands, meaning they are not intentionally flooded, drained, or irrigated. Early attempts were made to farm or flood some of these areas, but most failed due to the alkalinity.

4.2.1. Seasonally Flooded Wetlands

Seasonally flooded wetland (SFW) is the most common habitat type on the Complex, and comprises 85-90 percent of the total managed wetlands on the four Refuges (Table 4). SFW provide the greatest density and diversity of food and cover for waterfowl and other migratory birds. Consequently, it supports the greatest abundance and diversity of wildlife species over the course of a year. During the non-breeding season (September-April), SFW can support up to three times the average waterfowl densities of semi-permanent wetlands and 10 times that of permanent wetlands (M. Wolder, unpublished data). These wetlands are intensively managed, with the timing and depths of water and vegetation manipulated to meet resource management objectives. In general, they are wet from fall through spring and dry during the summer.

Marsh wren
Photo by Steve Emmons

Characteristic plants include emergent species, such as hardstem bulrush, cattail, and both alkali and tuberous bulrush. Wildlife forage species include swamp timothy, smartweeds, and watergrass. The ratio of open water to emergent plants often determines the species that will use a particular area. For example, pintail, shoveler, wigeon, most geese, and shorebirds are species attracted to marshes which have more open water and less emergent cover. When SFW is dry during the summer, bulrushes and other vegetation function as habitat for ground-nesting birds.

A percentage of SFWs receives a single irrigation during the spring or early summer, and are referred to as watergrass (WG) units. Watergrass habitat comprises about 10 to 15 percent of the total managed wetland acres. It typically contains a large volume of seeds, including watergrass, smartweed, and other moist-soil species that

are especially sought-after by waterfowl early and late in the season. Along with other seasonal wetlands, WG units play a role in providing alternate food resources in the early fall to help prevent crop depredation on private agricultural lands.

4.2.2. Summer Wetlands

Summer wetlands (SW) include permanent and semi-permanent wetlands. They provide wetland habitat during all or part of the summer, as well as most of the rest of the year. Summer wetlands comprise approximately 10 to 15 percent of the total managed wetlands (Table 4). Vegetation includes an abundance of perennial emergents (cattails and bulrushes), floating-leaved submergents (bur-head, arrowheads, etc.), and pondweeds (sago, horned, etc.). SW provide important breeding habitat for waterfowl and many other wetland-dependent species including egrets, bitterns, ibis, grebes, rails, tricolored blackbirds, giant garter snakes, and northwestern pond turtles. They are also important water sources for all wildlife during the summer, when most seasonal marshes are dry. Historically, permanent and semi-permanent wetlands have been referred to as “permanent ponds” and “summer water,” respectively in Complex habitat management plans and other documents.

Mallard with ducklings
Photo by Steven Emmons

4.2.3. Unmanaged Wetlands

Wetlands, other than vernal pools, that are largely natural and have little or no artificial water management capabilities are referred to as “unmanaged wetlands.” They include oxbow lakes, sloughs, and other watercourses. They are typically more permanent or semi-permanent wetlands that are heavily vegetated. The limited acres of unmanaged wetlands provide habitat for giant garter snakes, western pond turtles, wood ducks, and other species.

4.2.4. Vernal Pools/Alkali Meadows

Natural vegetation at Colusa Basin refuges is best characterized as saline vernal pools of the Colusa–Solano Region (Barbour et al. 2003;

Holland 1978) and alkali meadow plant communities (Griggs et al. 1992; Holland 1986; Silveira 2000). These Refuges also share a similar flora with native salt-tolerant plants, managed freshwater emergent plants, and weedy annual grasses (Oswald and Silveira 1995, 2003 Supplement). A majority of the alkali meadow forbs are natives, while most of the grasses are non-natives (Wight 2000).

Vernal pools are seasonally flooded depressions found on ancient soils with an impermeable layer (duripan) such as a hardpan or claypan that perches rainwater above the water table. The Riz soil series, which has developed on the Modesto Formation, is associated with a claypan. The Willows soil series is not associated with a duripan, but the high clay content associated with high concentrations of alkali impedes percolation of water and causes rainwater to perch above the water table in depressions forming vernal pools. They are generally filled and maintained with rainwater in the winter and early spring, then evaporate as temperatures warm and north winds blow in late spring. While temporary wetlands such as vernal (spring) pools occur throughout the earth, those of California are unique due to a Mediterranean (winter wet–summer dry) climate; thus the flora and some of the fauna of vernal pools are unique to California (Holland and Jain 1988). Since vernal pools support a significant amount of endemic and rare flora and fauna, they add significantly to the biotic diversity of the Refuges (Silveira 2000; Eriksen and Belk 1999; Thorp and Leong 1995); as a result, they are a high conservation priority. A sample of California vernal pool endemics include: Fremont's goldfields; alkali goldfields; Scribe's popcornflower; Hoover's downingia; folded downingia; vernal pool saltbush; Hoover's spurge; cleistogamous spike primrose; tiny mouse-tail; Colusa grass; hairy Orcutt grass; Solono grass; California clam shrimp; California fairy shrimp; Conservancy fairy shrimp; midvalley fairy shrimp; and, vernal pool tadpole shrimp.

As winter rains fill the pools, a variety of crustaceans and other invertebrates emerge, develop, and reproduce, completing their entire life cycle in a single wet season. Vernal pools provide habitat for the greatest diversity of fairy shrimp on earth and most of them are endemic to California (Eriksen and Belk 1999). Vernal pool plants germinate, some underwater, some using special floating leaves and air-filled stems to stay afloat. Vernal pools and their surrounding plant communities are important habitats for a variety of migratory birds (Silveira 1998; Bogiatto and Karnegis 2006). Some of the most intensive shorebird use on the Refuges occurs on vernal pools (Wolder et al. 1999).

As water evaporates in the spring, flowering plants produce the brightly colored concentric rings of flowers for which vernal pools are famous. Host-specific native bees nest in the plant communities, which surround vernal pools and pollinate pool flowers; many of these native pollinators are endemic species (Thorpe and Leong 1995).

Aquatic insects and crustaceans produce cysts and eggs and plants produce seeds that are buried in the muddy pool bottom, all of which remain dormant in the dry pools until they are flooded again the following winter. In their dry phase, vernal pools are really "banks" full of resting seeds, cysts, and eggs that are adapted to survive through summer, and even extended droughts.

Vernal pool at Sacramento Refuge
Photo by Joe Silveira

Alkali and salt tolerant vegetation grows on Basin Rim landforms, which are elevated slightly above the valley or basin floor. Here, the plant rooting zone and soil surface is near the water table, so salts (at the Refuge, sodium) which increase alkalinity are carried to the rooting zone or to the surface forming white-crusted alkali scalds and “fluffs.” Alkali meadows are characterized by halophytes (salt-tolerant plants) and form a unique vegetation, which is sparsely vegetated and relatively short. Alkali meadows are often found in association with vernal pools at the Complex. While they do not pond water like vernal pools, the soil becomes completely saturated with winter and spring rainfall. Similar to vernal pools, they support a variety of native endemic plant and animal species that are uniquely adapted to their environment. Examples of California alkali meadow/vernal pool endemics include: pappose spikeweed; Heckard’s pepper-grass; heart-scale; brittlescale; Ferris’s milk-vetch; palmate-bracted bird’s-beak; and, the Delta green ground beetle.

Vernal pools and alkali meadows occur most commonly at Sacramento, Delevan, and Colusa Refuges (Table 4). They are a remnant of the original “Colusa Plains” identified by early settlers as the area west of the Sacramento River in the Colusa Basin. The habitat was also historically known as “alkali gooseland,” as thousands of geese used and continues to seek out these areas for grazing. Vernal pools and alkali meadows are technically wetlands, but have been historically considered part of the overall “uplands” habitat group.

4.3. Grasslands

True upland habitats are relatively uncommon on the Refuges, and include annual and perennial grasslands (Table 4). Perennial grasslands include some recently restored natives adapted to the less alkali soils, and introduced non-native species of tall wheatgrass and Harding or perla-grass. Grassland cover provides nesting habitat for ducks, pheasants, meadowlarks, burrowing owls, and other grassland species. Preliminary monitoring of native grass restoration work at Colusa Refuge indicated comparable duck nest densities with other off-refuge areas, but with overall higher nest success (Loughman et al. 2004). American bitterns and northern harriers also nest in these areas. During the winter and spring, short grass uplands provide green browse for geese, wigeon, and coots. Uplands also support significant numbers of insects, rodents, and reptiles, which, in turn, are important forage items for raptors and other birds. Many of the non-native grass species are invasive and pose a threat to alkali meadow vegetation and the rare, endemic, and native species that grow there. As a result, they are controlled in some areas.

4.4. Riparian Habitats

Riparian habitats comprise a relatively small proportion of these four Refuges (Table 4). Narrow bands of Goodding's black willow, and sometimes, narrow-leaved willow, form willow scrub stands along Logan and Stone Corral Creeks, the Colusa Basin Drain, and several other water delivery and drainage canals of the Refuges. At Sacramento Refuge, a cottonwood willow stand, known locally as "Sherwood Forest," occurs on a small portion of the south half of the Refuge. At Colusa Refuge valley oak riparian forest occurs along Powell Slough, a small area along the Colusa Basin Drain. Mixed riparian forest occurs along the Sutter Bypass canals at Sutter Refuge and comprises the largest patches of forested habitat of the four Refuges.

Willow scrub forms open-to-dense shrubby willow-dominated thickets with little to no understory vegetation (Holland 1986). It occurs along the creeks, sloughs, canals, and drains of the Refuges. Cottonwood willow is forested habitat containing open–to-dense stands co-dominated by willows and Fremont's cottonwood. Valley oak riparian forest is dominated by valley oak and includes an understory of box elder, wild rose, poison oak, and alkali (creeping) ryegrass (Holland 1986; Holland and Roye 1989). Mixed riparian forest is a forest vegetation type consisting of later successional species, such as valley oak (Holland 1986; Holland and Roye 1989). Valley oak accounts for less than 60 percent of the canopy coverage with black walnut and Oregon ash also present. Willows and cottonwood may also be present in relatively low abundance. The dense understory often consists of Oregon ash, box elder, poison oak, and wild grape. Wild rose is also a common understory plant.

Riparian habitats are used by a great variety of Neotropical migrant bird species, including the yellow-billed cuckoo, yellow-rumped warbler, black-headed grosbeak, and spotted towhee. Because of their close proximity to water, riparian scrub and forest habitats attract a large array of "wetland-dependant" species, such as the northwestern pond turtle, great blue heron, great egret, wood duck, common yellowthroat, song sparrow, beaver, and river otter.

River otters
Photo by Mike Carpenter

4.5. Agricultural Croplands

Grain crops were annually grown on a number of the Refuge units in the 1940s through the mid-1980s, primarily to provide food for waterfowl and lure them away from crops on nearby private lands (USFWS 1937-1995). Rice and barley were the most common initially, but by the 1970s, rice was grown almost exclusively, totaling about 2,600 acres on the four Refuges. A rice-millet (watergrass) fallow rotation was commonly used on certain units to maintain productivity and help control weeds.

By the 1980s, it was apparent that harvested rice fields had become an abundant habitat type throughout the Sacramento Valley, while freshwater marsh and other natural wetlands had a declining trend and were becoming relatively scarce. The Sacramento Valley Waterfowl Habitat Management Committee (1983) recommended termination of rice farming programs on the Complex. Reduced water availability and budget constraints had also made rice agriculture difficult. In addition, wetland management techniques were producing significant quantities of watergrass and other moist-soil food plants. As a result, rice farming on the Refuges began to be phased out in 1984, with no significant increases in depredation complaints. The last crop of rice grown on the Complex was in 1988 (USFWS 1937-95, vol. 1990), and all previous rice fields were eventually converted to managed wetlands (Strong et al. 1990; Mensik 1993a).

5. Habitat Management

Habitat management strategies are considered at the Complex, Refuge, and individual unit level. This management philosophy acknowledges conservation needs of both spatial and seasonal distributions of different wildlife and plant species. Because of the highly mobile nature of migratory birds, their populations readily shift among the various basins in the Central Valley (CVJV 2006) and individual Refuges within the Complex. For example, wintering waterfowl typically shift from northern and western areas of the Sacramento Valley (including Sacramento and Delevan Refuges) in the early fall to more eastern and southern areas in winter and spring (including Sutter and Colusa Refuges, USFWS 1989-2007). In this case, food and other habitat resources are provided through strategic flood-up scheduling among the Refuges over the course of the year to accommodate these seasonal and geographic needs.

At the refuge level, habitat is manipulated through a variety of methods (mostly water and vegetation management) to achieve functional percentages of different habitat types. This would include meeting objectives for the ratio and spatial distribution of breeding to non-breeding habitat types (i.e. summer versus seasonal wetlands).

Conversely, extremely rare species with limited distributions may require intensive management at the unit level to conserve or enhance them (i.e. endangered plants, colonial nesting bird rookeries or other localized nesting sites).

There are approximately 270 separate management units on the Sacramento, Delevan, Colusa, and Sutter Refuges (USFWS 1989-2007). Intensively managed wetlands comprise the majority of those units. In order to more effectively maintain, manage, and monitor these Refuges, a habitat management system was implemented in the early 1980s (Mensik and O'Halloran 1990). The system has evolved with several modifications and additions, along with some upgraded technology, and has been successfully used at the Complex for over 20 years.

Refuge management is determined, guided, and tracked by an annual habitat management planning process (USFWS 2002a; USFWS 1988-2007). The annual cycle of this process starts in the spring with the generation of an annual habitat management plan (Appendix E) for each Refuge. Refuges are toured by staff in the late winter, during which each management unit is visited and evaluated. Staff on these tours includes the refuge manager, biologist, work leader, irrigator, outdoor recreation planner, fire management officer, and law enforcement officer. Each unit is evaluated based upon what was planned the previous year compared to what actually was accomplished in terms of management activities (such as water regimes, vegetation control, visitor service improvements, etc.), repairs (i.e. levees or replacement of water control structures), and

the resulting habitat condition, wildlife use, or other resource data. Data and observations collected during the year are presented and discussed. Nearly all of this data is collected by unit, so it can be compared and evaluated. Examples include vegetation species composition, wildlife survey data, disease mortality, wetland drawdown and flood-up dates, vegetation control measures conducted (i.e. prescribed burning, disking, etc.), quality of visitor service opportunities (i.e. wildlife observation on tour routes, hunting success, etc.), and law enforcement issues. Annual habitat management plans (Appendix E) are then generated for each Refuge with participation, input, and review from the above staff. This process also involves a number of other considerations including, but not limited to, refuge purposes, Service management directives (i.e. Improvement Act), historic habitat conditions, other regional habitat plans (i.e. Central Valley Joint Venture Implementation Plan), Flyway management plans, endemic species conservation, endangered species recovery plans, and specific resource needs.

Black-tailed deer in Colusa Refuge
Photo by Mike Peters

Data, reports, and documents that are used in the plan are stored and generated in a computer database. These plans identify individual management units within each Refuge. These units consist of tracts of land which have common management constraints, conditions, and visitor service activities. The habitat management plan identifies physical attributes of the unit, habitat objectives, specifies management activities to make any necessary repairs or improvements; emphasizes positive results from previous years; and notes special management considerations (i.e. presence of special status species or other significant wildlife use). It also prioritizes management activities and projects based on the overall condition and functionality of the unit, water management regimes (i.e. flood-up and drawdown schedules), and available resources (i.e. manpower and funding). Examples of management activities include facilities maintenance (i.e. levees, water control structures, roads, fire breaks, fences, gates, boundary signs, etc.), vegetation management (i.e.

herbicide application, prescribed fire, grazing, mowing and disking, irrigation, etc.), biological surveys, habitat restoration, research, visitor service monitoring and facilities maintenance, and law enforcement issues.

The result is a document that is distributed to all staff members for reference and to serve as a place to keep notes on their respective programs and responsibilities. Their information is then used to help generate the following year's plan. In summary, the habitat management plan facilitates the adaptive management process. It allows for modification within or between years based on changing conditions, serves as a place to input current data from all Refuge programs to be considered together, and helps to ensure that informed management decisions are made.

5.1. Water Management

Proper water management is considered essential to maintaining high quality wetlands and meeting the purposes, goals, and objectives of the Complex. This includes maximizing benefits for wildlife, emphasizing feeding and resting areas for wintering waterfowl and other migratory birds. Adequate flows of water through wetland units are maintained to promote water quality. At Sutter Refuge, this is particularly important to provide passage of migrating juvenile salmonids during periods when they may be present.

Water management is the most important tool for vegetation production and control in wetlands. The water management regime, specifically the timing, depth, and duration of inundation, is often the greatest contributor to the resulting wetland vegetation, whether desirable or undesirable (Mensik and Reid 1995). Spring drawdown dates largely determine the species that germinate in seasonal wetlands (Strong et al. 1990). If drawdowns are conducted too early, less desirable cool season emergents and upland grasses will dominate. Conversely, if conducted too late, pond bottoms dry too quickly and plant germination and survival will be poor overall. Water level management is also critical to providing available habitat to certain wildlife species at certain times of year (Helmers 1992; Isola 1998). For example, providing a variety of shallow water levels from 0.3 to 13.4 inches (0.8 to 34 cm) offers attractive foraging habitat for most dabbling ducks (Heitmeyer and Raveling 1988) and shorebirds (Isola 1998). Conversely, deeper water wetlands are needed to support diving birds, such as diving ducks, grebes, cormorants, and pelicans. Managed wetlands typically provide a range of shallow to deep-water areas, but enhancement techniques (Strong et al. 1990) are used to create and maintain this diversity in previously farmed or leveled units.

Most wetlands are created and maintained on man-made impoundments, using BOR/CVPIA water that is delivered through local irrigation districts. The wetlands are flooded up and drawn

down with near complete control through inlet and outlet structures. The number of management units dedicated to wetlands ranges from about 25 on Sutter Refuge to 110 on Sacramento Refuge. Flooding regimes are designed to mimic historic wetland patterns as closely as possible, given water availability and wetland losses. Furthermore, the timing of drawdowns, irrigations, and floodups largely dictates plant species composition (i.e. germination and growth of desirable food and cover plants). It also governs habitat availability (i.e. how much wetland is flooded at certain times of the year for certain wildlife species).

The amount of water needed each month to manage various wetland habitat types is based upon when/how long they are flooded/maintained over the course of a year (Table 5).

Table 5. Approximate number of acre-feet/acre/month required for each wetland habitat type on the Complex.

	Currently Available (acre-feet/acre)								Projected (acre-feet/acre)				Totals (acre-feet/acre)	
HABITAT	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	Current	Yearly
Seasonal flooded wetlands Sept 1 – Apr 1					0.50 Flood-up	2.00	1.00	0.75	0.25	0.25	0.25	0.50	4.25	5.50
Watergrass Sept 1 – May 1	1.00		1.50 Irriga-tion			2.00 Flood-up	1.00	0.75	0.25	0.25	0.25	0.50	6.25	7.50
Summer Water Oct 1 – July 15	1.00	1.00	2.00	1.00			2.00 Flood-up	0.75	0.25	0.25	0.25	0.50	7.75	9.00
Permanent Pond Jan 1- Dec 31	1.00	1.50	2.00	2.00	2.00	1.75	1.00	0.75	0.25	0.25	0.25	0.50	12.00	13.25

5.1.1. Seasonally flooded wetlands

During the fall and winter months, water levels in most seasonally flooded wetland (SFW) units are kept relatively shallow ($\leq$12 inches), with portions of some units up to 36 inches. In the spring, water levels in individual SFW units are slowly drawn down to mostly mudflat, typically over a period of 10 to 20 days. These unit drawdowns are staggered over the period of March-May, with peak drawdown acres occurring in April to coincide with the spring shorebird migration. As water is removed, migrating shorebirds and other waterbirds utilize the shallow water areas and mudflats to feed on invertebrates, fish, and other food items that are concentrated in the receding water. Seed-producing plants germinate and grow to maturity on the moist pond bottoms during the spring and summer. In the fall, individual units are

flooded on a staggered schedule (similar to spring drawdowns) between late August and November, making appropriate amounts of habitat available to fall migrating birds and other wildlife as their numbers increase.

Cinnamon Teal
Photo by Steve Emmons

5.1.2. Watergrass

Watergrass (WG) is simply a seasonal wetland that receives a late spring or summer irrigation as part of the management regime. WG units are usually drawn down in May, during warmer conditions that favor watergrass germination. A single irrigation is applied sometime between May and early July, depending on weather patterns and phenology of target plant species (Mensik 1993b) or target pest species (Mensik and Reid 1995). Rapid irrigations are desirable, ideally lasting 7-10 days to minimize both mosquito production and the growth of undesirable plant species such as jointgrass or Bermuda grass (Kwasny et al. 2004). During irrigation and drawdown periods, WG units are used by duck broods, long-legged waterbirds (e.g. egrets, herons, ibis), and giant garter snakes for foraging and cover. After irrigations, WG remains dry until flooded up in August or September. During this dry period, any prescribed vegetation management such as disking or mowing will be conducted. By flooding these habitats in late summer or early fall, early migrating waterfowl are provided abundant food resources that might otherwise be obtained from agricultural crops (primarily rice) on private lands. Colusa and Sutter Refuges were authorized, at least partially, by the Lea Act; therefore, reducing crop depredation is a major goal of both Refuges.

5.1.3. Summer wetlands

Consisting of both semi-permanent and permanent wetlands, summer wetlands (SW) water depths range from 12 to 48 inches. Water levels are maintained at consistent levels, to the extent possible, to minimize negative impacts to birds that build their nests over the water, growth of undesirable vegetation, and

mosquito production. A flow-though of water is also maintained to reduce potential for avian botulism outbreaks. SW is typically managed and maintained through one of three (two semi-permanent and one permanent) water management regimes.

The first water management strategy is to keep units flooded into the summer and draw them down in July or August, after the breeding season. Staggered drawdowns for these units during this time attract and support shorebirds during important fall migration periods (CVJV 2006). They also provide significant foraging sites for a variety of other waterbirds. After drawdowns, the units are then reflooded during the fall. During the non-growing season (i.e. November-April, varies with year), SW units are drawn down to even more shallow levels to encourage use by wintering waterfowl and other wildlife.

The second strategy is to flood and maintain throughout the year as a permanent wetland. Permanent wetlands may be maintained for up to five years or more, but without periodic drawdowns, productivity decreases over time. In addition, emergent vegetation grows relatively fast and its density can become a problem. As a result, these units are typically drawn down every three to five years to recycle nutrients, discourage carp populations (which are detrimental to desirable submerged aquatic vegetation), and conduct any required maintenance or vegetation control.

Occasionally, a third approach is employed involving a spring drawdown to accommodate any maintenance required (i.e. levee repair, water control structure replacement, etc.), after which the unit is immediately reflooded for the remainder of the season.

Any of these strategies may be employed in the short-term (i.e. for one year out of many) to encourage growth of emergent plants to enhance sparsely vegetated units.

5.1.4. Vernal Pools and Alkali Meadows

Management of vernal pool and alkali meadows is much less intensive than managed wetlands. Water management on vernal pools is not artificially manipulated and, in fact, special emphasis is made to restore and maintain natural hydrology as much as possible (Silveira 2007; USFWS 1999b; Ducks Unlimited 2005a, 2005b). They are allowed to flood and dry naturally, based on precipitation or natural flood events and evaporation. This cycle is what helps maintain the abundance and variety of rare and endemic plant and animal species that exist on these sites.

5.2. Vegetation Management

Vegetation management is relatively common on the Refuges, and is generally used to control the abundance of certain plant species or their distribution, and to enhance desirable species (Mensik 1990;

Mensik and Reid 1995). A number of invasive species occur throughout the Refuges habitat types and infrastructure (i.e. canals, levees, roads, etc.), requiring different levels of control (Table 6). The area's mild climate creates a year-round growing season that results in the germination and expansion of at least some undesirable species throughout the year.

Reasons for vegetation management include maintaining biodiversity, maintaining desirable proportions of emergent vegetation in wetlands, enhancement of desirable species, reduction of undesirable species, preparation for habitat restoration projects, reducing mosquito breeding habitat, and maintenance and safety around facilities including protecting communities and assets at risk to wildfire. A variety of vegetation management techniques (mow, disk, burn, spray, etc.) are used, depending on the habitat type, plant species, and resource objectives. Some are used alone, while others may be used in combination with one or more other techniques. In general, mechanical methods are preferred over herbicides, but in some cases, the opposite is true (i.e. to avoid ground disturbance an herbicide may be the most effective method). The need to use any of these techniques annually depends on species present, condition of the habitat, effects of climate on plant growth, available funding and resources, and in some cases, the extent to which legal mandates allow the selected technique (i.e. burning restrictions due to local air quality legislation). Vegetation management is a primary component of the annual habitat management plans, where control and enhancement objectives are identified and treatments are prescribed to achieve them.

5.2.1. Prescribed Burning

Prescribed burning is used in wetland, vernal pool/alkali meadow, and grassland habitats to remove hazardous fuel loads, control non-native invasive species, as well as to enhance and maintain habitat values. Burning in wetland areas is generally used to reduce perennial vegetation that has expanded to a point that decreased wildlife use and overall productivity has resulted. Examples include wetlands where long-term expansion of hard-stemmed bulrush and cattail growth have exceeded the optimum range of emergent vegetation and open water, or where Bermuda grass or jointgrass has replaced the majority of annual moist soil food plants, thus reducing the use by many wildlife species (Mensik 1990). These burns also serve to break up large stands of continuous fuel beds that can result in larger more destructive wildfires. Typically, prescribed burns are applied to managed wetlands during spring or summer. Depending on conditions and habitat objectives, both dry and overwater burning can be successful. Fire lines are disked around the burn area and buffers are disked around any trees to be saved. The firing pattern allows for an avenue or direction of escape for wildlife. In some cases, burning is conducted over water to increase controllability. Follow-up disking is often used to ensure that roots of target species (i.e. hard-

stemmed bulrush, cattail, jointgrass, etc.) are killed and enhance germination of desirable species (Mensik 1990; Mensik and Reid 1995). The result is a desirable mix of vegetation species, stature, and distribution; a recycling of nutrients; and a successional stage that is more productive and reduces the risk to life and property from larger more destructive wildfires. The frequency of burning wetland units depends on habitat type, vegetation species composition, soil type, and tendency for growth. In some cases, this may be as often as once every five years and in others, it may be one in 20 to 30 years.

Prescribed burns in grasslands, alkali meadows, and vernal pools are used to reduce invasive species and stimulate native plant species (Pollak and Kan 1998; Wight 2000). Resource benefits include maintaining biodiversity (especially native plant communities and the wildlife they support), providing browse for waterfowl, and general maintenance of habitat for short grass wildlife species. These burns also reduce the risk of large unwanted wildfires by reducing the accumulation of hazardous fuels and establishing a mosaic of fuel loads. Burns may occur at any time of year, depending on specific objectives and condition of the habitat. Fall or winter burns are usually used when sensitive plants are present because they are dormant at that time. For optimal control of annual grasses, it is most effective to burn in the late spring/early summer, when seeds remain on the plants and can be easily consumed by the fire.

Prescribed burning
Photo by Kipp Morrill

Annually, 500 to 2,000 acres of wetland, vernal pool/alkali meadow, and grassland habitats are burned on the four Refuges. Prescribed burns are conducted in accordance with both Department of the Interior and Service Fire Management Policy (621 FW 1-3 of the Service Manual). Use of prescribed burns for habitat management and hazardous fuel reduction is consistent with both the approved habitat and Fire Management Plans for the Complex (Appendix J). Individual prescribed burn plans are written, reviewed, and approved

for each unit as outlined in the Interagency Prescribed Fire Guide. They include a variety of information detailing how the burn will be conducted, considerations for safety, and measures to minimize impacts to sensitive species and air quality. All prescribed burns are conducted in compliance with the Clean Air Act and associated permitting requirements.

5.2.2. Disking

Disking is an important management tool that has a variety of uses. It is commonly used in managed wetlands to reduce vegetation that has exceeded beneficial quantities or distributions required for wildlife use objectives. By itself, or in combination with burning or spraying, disking helps control bulrushes, cattails, Bermuda grass, jointgrass, primrose, and other perennial plant species (Mensik 1990; Mensik and Reid 1995). In addition to controlling undesirable plants, disking also creates a seedbed conducive to both increased germination and seed production of desirable moist soil plants in seasonal wetlands (Naylor 2002). Caution must be exercised in some wetlands, where disking can enhance or spread invasive species, such as cocklebur and pepperweed. Disking is often used in thick vegetation to create openings that facilitate bird disease monitoring and carcass removal, as well as to increase wildlife viewing opportunities. Waterbird loafing areas can be greatly enhanced by reducing vegetation on islands and interior levees. As the use of prescribed burning has declined due to local air quality restrictions, disking has become a more frequent vegetation control option. Disked fuel breaks are particularly effective in the Wildland Urban Interface (WUI) where prescribed burns are more difficult. Disked fuel breaks are used to protect life and property from the spread of wildfire off of and onto the Refuges.

Disking jointgrass
Photo by Mike Carpenter

Disking is typically conducted during late spring, summer or early fall months when wetlands are dry. Target species/areas may be

disked one or more times to ensure that roots are dead, reducing the need for more frequent treatments. Vegetation succession is set back in disked areas, and typically desirable moist soil plants and open water areas replace the species that are removed. Multiple disk passes are sometimes necessary to break up large clods for optimal germination.

Circumstances dictate how much of an area will be disked. In most cases, a mosaic pattern is created, leaving equal proportions of emergent cover plants and open areas with annual moist soil plants. The amount left undisked may be altered if special needs for certain species are identified (Mensik and Reid 1995). Examples include leaving more emergent vegetation in units that have historical use by colonial nesting birds, such as tricolored blackbirds or white-faced ibis, or leaving less vegetation in units that support large numbers of open water species, such as pintails or shorebirds. In cases of widespread problem vegetation, sometimes the most cost-effective treatment is for the majority of a unit to be disked, realizing that the benefits will last a minimum of 3 to 5 years (Mensik and Reid 1995).

5.2.3. Mowing

Mowing is used to control a variety of invasive species, enhance wetlands, reduce fire risk, and accomplish general weed maintenance around facilities. It is usually conducted with a tractor pulling a large mowing implement, but may also be accomplished with smaller equipment, such as push mowers or weed eaters.

Mowing cocklebur
Photo by Mike Carpenter

In wetlands, mowing is a primary tool for controlling cocklebur, an invasive species that can overtake seasonal wetlands and crowd out more desirable species (Mensik and Reid 1995). By mowing prior to plants setting seed, cocklebur can be kept under control, resulting in a greater diversity of desirable species, while reducing the need to

use herbicides. Mowing is also used for keeping islands and selected sections of levees clear of vegetation. This greatly enhances wetlands by creating optimal loafing and resting sites for waterfowl, shorebirds, and other wildlife. Whenever possible, mowing is used instead of disking in order to minimize erosion and invasive species expansion.

Invasive vegetation in upland habitats is also managed with mowing, although burning or grazing are preferred in most cases. Yellow starthistle and non-native grasses such as annual ryegrass can be significantly reduced by mowing, but timing is critical (Thomsen et al. 1997).

A number of roads, levees, and areas around buildings and other facilities are mowed during the spring and summer to minimize risk of wildfires by allowing safer access to complete habitat management tasks (i.e. checking water control structures), conduct biological surveys, and perform general maintenance.

5.2.4. Spraying

When mechanical or biological methods are ineffective or impractical, herbicides are used on the Refuges for invasive species control. All herbicide use is reviewed and approved through the same Pesticide Use Proposal (PUP) process (7 RM 14 of the Refuge Manual). A PUP is prepared for each material used. It identifies target species; reason for application; application rate, timing, and method; sensitive areas and species that may be affected and measures to avoid impacts to them. PUPs are reviewed and can be approved by the refuge manager, regional office, or Washington office, depending on the type of material used. For more information, see the Integrated Pest Management Plan in Appendix F.

Herbicide spraying
Photo by Mike Carpenter

5.2.5. Water Management (for vegetation control)

Water management is the most important tool for vegetation enhancement and control in wetlands. The timing, depth, and duration of flooding can be manipulated to enhance desirable moist soil plants and reduce certain undesirable species. Short-term irrigations (7-10 days) conducted in the spring and summer can

greatly increase the amount of moist soil plant seed production (Naylor 2002) and vegetative stature in seasonal wetlands. One irrigation is typically all that is necessary to bring seedling plants to maturity.

Cocklebur, a common invasive species in seasonal wetlands, is particularly susceptible to control by flooding at a critical point in its life cycle. As with many desirable species, such as watergrass or smartweeds, cocklebur seedlings germinate on seasonal wetland pond bottoms as they dry in spring. To control cocklebur, reflooding the wetlands for one to two weeks at the right time can kill cocklebur seedlings, while at the same time encouraging the growth of desirable species.

However, if irrigated for a prolonged period, problem species such as Bermuda grass or jointgrass, can rapidly encroach, resulting in decreased overall productivity for wildlife and potentially unacceptable levels of mosquito production (a human health issue in some areas).

5.2.6. Restoration of native species

Where appropriate, native vegetation is restored on the Refuge using a variety of grasses, forbs, shrubs, or tree species depending on habitat and wildlife objectives. Planting seeds, plugs, and cuttings are the most common methods for establishing native vegetation. The use of the most local genetic stocks for any plantings helps to increase the chance of success.

5.2.7. Prescribed livestock grazing

Historically, grazing by native wildlife species has shaped the botanical and zoological resources of the California landscape (Edwards 1992, 1996). Currently, well managed livestock grazing is an important method of vegetation management (Barry 2003; Griggs 2000) on the Refuges. Benefits associated with the grazing program include: the reduction of plant material; reduction in non-native invasive weeds (Thomsen et al. 1993); increases in native plants, including special status plant species due to reduced competition for sunlight, reduced competition with non-native annual grasses for water and nutrients (Coppoletta and Moritsch 2001; Davis and Sherman 1992; Menke 1992; Muir and Moseley 1994); increased primary production and resultant increases in plant biomass (McNaughton 1985); increases in native vernal pool and grassland wildflowers (Marty 2004, 2005), with consequent increases in macro-invertebrate populations, including native pollinators of native plants, and prey items for Refuge wildlife such as migratory land birds like the horned lark and savanna sparrow; and increases in the inundation period with habitat benefits to vernal pool crustaceans (Pyke and Marty 2005). Grazing provides optimal shorebird and sandhill crane foraging habitat by reducing grass height and contributing organic matter for the prey base (Colwell and Dodd 1995; Knopf and Rupert

1995) and also provides short, nutritious grasses for grazing migratory waterfowl (Buchsbaum et al. 1986) and local deer. Aquatic invertebrates, insects, and special status species associated with vernal pool and vernal pool/alkali meadow complexes benefit from grazed herbaceous habitats (Bratton 1990; Bratton and Fryer 1990; Panzer 1988; Germano et al. 2001), especially cattle grazing (Marty 2004, 2005). Grazed areas support increased numbers of primary burrowing mammals such as the California ground squirrel and secondary burrowing animals, such as burrowing owls and various snakes.

Grazing can also impact some Refuge wildlife and habitat, including reducing nesting cover for some nesting waterfowl and songbirds, (Kirsch 1969; Krueper 1993), as well as for the northern harrier and American bittern. Mammals which burrow through thatch, such as California meadow vole, would likely decrease with grazing. However, these impacts would be short-term because the program would stipulate seasonal grazing (Appendix B, Grazing Compatibility Determination).

Burrowing owl
Photo by Mike Peters

Primary, long-term benefits from the grazing program include continued annual native plant production, non-native invasive plant species control, and maintenance of annual or seasonal use of Refuge habitat by migratory birds and resident deer herds. Periodic grazing can also lessen the threat of wildfire near rural structures and agricultural industrial facilities.

Overall, the short-term impacts of seasonal grazing on local ground-nesting birds and some small mammals would be mitigated by the long-term improvements to Refuge plant species composition and structure, native plants, and overall wildlife habitat quality that would benefit migratory birds, resident deer herds and nesting habitat condition.

Grazing is facilitated through the Cooperative Land Management Agreement (CLMA) or Refuge Special Use Permit (SUP) with a local cooperator. Benefits of the CLMA program are the cooperator's shared responsibilities in maintaining corals, fences, gates, cattle water systems, and vegetation management/invasive weed control.

5.3. Control of Invasive, Exotic, or Pest Species

It is necessary to control certain plant and animal species that have undesirable effects on Refuge animals, plants, and their habitats or pose a health risk. The Refuges actively control or permit the control of a number of invasive and/or exotic plants (Table 6), problematic animals, and disease vectors. Invasive plant species compete with desirable plants for space, sunlight, nutrients, and water. They have detrimental effects on the distribution and abundance of plants that are important to wildlife as food, shelter, and nesting areas. In some cases, certain plants may be desirable in modest proportions, but can be detrimental to diversity and productivity if they become dominant.

The Service Pest Management Policy goal (30 AM 12.1 of the Administrative Manual) is to eliminate the unnecessary use of pesticides through the use of Integrated Pest Management (IPM). IPM uses a combination of biological, physical, cultural, and chemical control methods (30 AM 12.5 of the Administrative Manual). This approach notes environmental hazards, efficacy, costs, and vulnerability of the pest.

When plants or animals are considered a pest, they are subject to control on national wildlife refuges if the pest organism represents a threat to human health, well-being, or private property; the acceptable level of damage by the pest has been exceeded; State or local governments have designated the pest as noxious; the pest organism is detrimental to primary Refuge objectives; and the planned control program will not conflict with the attainment of Refuge objectives or the purposes for which the Refuge is managed (7 RM 14.2 of the Refuge Manual).

The Refuges have developed a draft Integrated Pest Management Plan for the Complex (Appendix F) to control invasive, exotic, or pest plant species.

Table 6. Invasive Plant Species at Sacramento Refuge Complex.

Species [1]	Common Name	Habitat [2]
ASTERACEAE [Compositae]	**SUNFLOWER FAMILY**	
Centaurea solstitialis	YELLOW STAR-THISTLE	Grassland, fields, levees, roadsides, ditch banks
Lactuca serriola	PRICKLY LETTUCE	Grassland, fields, levees, roadsides, ditch banks
Xanthium strumarium	ROUGH COCKLEBUR	SFW, riparian habitats, vernal pools
BRASSICACEAE [Cruciferae]	**MUSTARD FAMILY**	
Lepidium latifolium	BROAD-LEAVED PEPPERWEED	SFW, riparian habitats, fields, levees, ditch banks
CHENOPODIACEAE	**GOOSEFOOT FAMILY**	
Salsola soda	FLESHY-LEAVED RUSSIAN-THISTLE	Alkali meadows, non-native alkali grassland
CONVOLVULACEAE	**MORNING-GLORY FAMILY**	
Convolvulus arvensis	BINDWEED	Vernal pools
FABACEAE	**LEGUME FAMILY**	
Robinia pseudoacacia	BLACK LOCUST	Riparian Forest
HALORAGACEAE	**WATER-MILFOIL FAMILY**	
Myriophyllum aquaticum	PARROT'S-FEATHER	Wetlands, ditches
JUGLANDACEAE	**WALNUT FAMILY**	
Juglans californica var. *hindsii* [3]	NORTHERN CALIFORNIA BLACK WALNUT	Riparian Forest
MORACEAE	**MULBERRY FAMILY**	
Ficus carica	FIG	Riparian Forest
MYRTACEAE	**MYRTLE FAMILY**	
Eucalyptus camaldulensis	RIVER RED GUM	Various
ONAGRACEAE	**EVENING-PRIMROSE FAMILY**	
Ludwigia peploides ssp. Peploides	YELLOW WATERWEED	Wetlands, ditches
Ludwigia peploides ssp. *Montevidensis*	MONTEVIDEO WATERWEED	Wetlands, ditches

Species [1]	Common Name	Habitat [2]
PHYTOLACCACEAE	**POKEWEED FAMILY**	
Phytolacca Americana	AMERICAN POKEWEED	Riparian, disturbed
SCROPHULARIACEAE	**FIGWORT FAMILY**	
Kickxia elatine	SHARP-LEAVED FLUELLIN	Various disturbed
SIMAROUBACEAE	**QUASSIA FAMILY**	
Ailanthus altissima	TREE-OF-HEAVEN	Riparian Forest
TAMARICACEAE	**TAMARISK FAMILY**	
Tamarix parviflora	SMALL-FLOWERED TAMARISK	Riparian habitats
Tamarix ramosissima	SALT-CEDAR	Riparian habitats
POACEAE [*Gramineae*]	**GRASS FAMILY**	
Arundo donax	GIANT-REED	Riparian habitats, ditches
Crypsis schoenoides	SWAMP-TIMOTHY	Vernal pools
Crypsis vaginiflora	AFRICAN PRICKLEGRASS	Vernal pools
Cynodon dactyton	BERMUDA-GRASS	Various
Elytrigia pontica ssp. *Pontica*	TALL WHEATGRASS	Alkali meadows
Phalaris aquatica	HARDING-GRASS, PERLA-GRASS	Alkali meadows
Lolium multiflorum	ANNUAL RYEGRASS	Various
Sorghum halepense	JOHNSONGRASS	Upland and wetland edges (fields, ditches, roadsides)
Taeniatherum caput-medusae	MEDUSA-HEAD	Uplands
Paspalum distichum	JOINTGRASS/KNOTGRASS	Managed wetlands
Rubus discolor	HIMALAYAN BLACKBERRY	Riparian habitats

[1] Non-native plants are indicated by an italic font. Severe problem plants indicated by underline.
[2] SFW – Seasonal-flooded Wetlands.
[3] Feral hybrid with commercial English walnut (*J. regia*).

5.4. Mosquito Management

The Complex is striving to responsibly address risks to public health and safety and to protect trust resources from mosquito-borne diseases and the impacts of mosquito pesticides on wildlife and the ecosystem. Refuge staff works cooperatively with the local Mosquito and Vector Control Districts (Districts) in the management of mosquitoes on the Refuges. Mosquito species found in the Central Valley include important vectors of potentially lethal diseases, including encephalitis and West Nile Virus. The Refuge has developed a draft Integrated Pest Management Plan for the Complex (Appendix F). The plan advocates a process to control mosquitoes, when necessary, using the least toxic methods first (i.e. wetland management techniques, biological controls) and only using chemical pesticides if less aggressive methods are ineffective. A significant component of the plan is the implementation of best management practices for minimizing mosquito production and mosquito control, which includes a variety of techniques for water and vegetation management and design features for managed wetlands (Kwasny et al. 2004).

The Service policy (7 RM 14 of the Refuge Manual) dictates that Pesticide Use Proposals (PUP) must be developed and reviewed prior to the application of any pesticide on a refuge. PUPs are developed annually on the Complex with input from the Districts. A PUP is prepared for each material used. It identifies target species; reason for application; application rate, timing, and method; sensitive areas and species that may be affected and measures to avoid impacts to them. Depending on the type of material used, PUPs are reviewed and can be approved at the refuge manager, regional office, or Washington office level. All PUPs are reviewed by the refuge manager for consistency with Departmental, Service, regional, and State policies.

Currently, there are varying levels of mosquito control that occur, depending on the refuge and annual conditions, such as weather and detection of disease. The use of adulticides is the most commonly used control method if wetland management techniques are unsuccessful. The Refuges continue to work with the local Districts to minimize adulticide use and look for additional ways to conduct mosquito control that are less toxic, such as some biological larvicides. Cost is often the reason larvicides are not more commonly used, and continues to be a major factor in trying to further implement their use.

6. Fish and Wildlife

Given the variety of habitats on the Complex, a great diversity of animal and plant species occur here. While many species are common year-round, others are here only during migration, for the winter, or during the spring and summer months to breed. Appendix K contains a complete list of fish and wildlife species that occur or potentially

could occur on the Sacramento, Delevan, Colusa, and Sutter Refuges. An overview of wildlife use of the Refuges follows.

6.1. Waterfowl

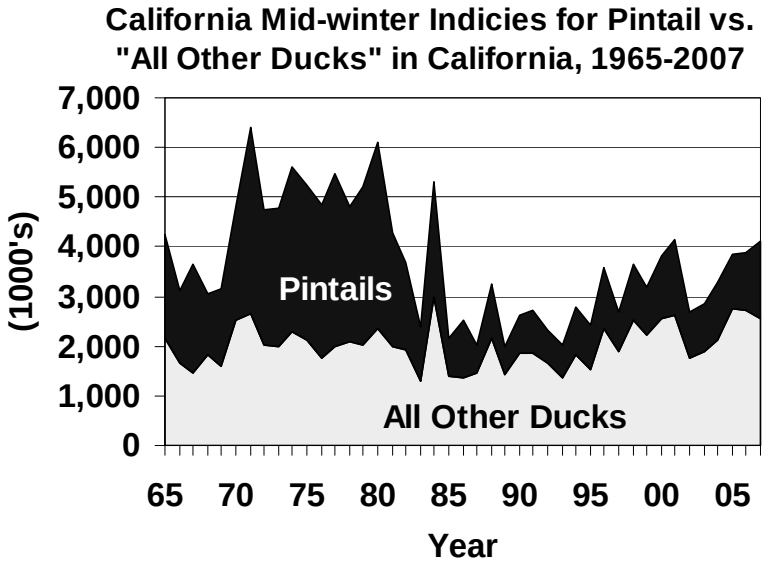
The Central Valley of California has always been a major wintering area for Pacific Flyway waterfowl. Populations have fluctuated over the last century, with some species experiencing significant declines, others showing dramatic recoveries, and still others that have shifted their distribution away from California. During the 1970s, California mid-winter waterfowl surveys, as indexed by the Mid-winter Indices, routinely estimated between four and six million ducks and five to six hundred thousand geese. Pintails comprised the majority of ducks, outnumbering all other species combined.

Northern Pintail
Photo by Steve Emmons

Following the 1970s, extended droughts in the Canadian prairie breeding areas caused significant declines in breeding ducks and production. These declines were also reflected in wintering numbers in California's Central Valley. Comparatively, in the last 25 years, wintering ducks in California (of which most are in the Central Valley) have fluctuated between two and four million ducks, including only about one to one and a half million pintails (USFWS 1955-2007) as shown in the Mid-winter Indices (Figure 10).

However, when the droughts in the prairies ended in the 1990s, most other duck species showed significant increases, but pintails showed only modest increases. There is evidence that changes in agricultural practices in the Canadian prairies initiated in the 1970s have negatively impacted the early nesting habitats of pintails and are thought to be the primary reason for the their lagging recovery (Miller et al. 2003, Guyn 2004).

Figure 10. California Mid-winter Indices (USFWS 1965-2007).



In general, goose populations have undergone some significant changes and shifts in the last thirty years. White-fronted and cackling cackling goose (cackler) populations reached their lowest levels in the early 1980s, due mainly to over harvest on both wintering and arctic breeding areas. Following the implementation of more restrictive harvest regulations, both these populations have rebounded dramatically. Although cackler populations have increased to a level of 150,000-200,000 birds, very few winter in California. Historically, about 90 percent wintered in the Central Valley and 10 percent in the Willamette Valley, Oregon. Today, this distribution has essentially reversed, largely due to turf agriculture in Oregon attracting the majority of wintering cacklers.

Aleutian cackling geese (Aleutian goose) represent another successful recovery story. On the brink of extinction with only about 800 birds in 1975, Aleutian goose populations have rebounded to over 100,000 today. This has largely been the result of removing non-native predators and repopulating geese on their key breeding areas in the Aleutian Islands (USFWS 2005a; Pacific Flyway Study Committee 1999; USFWS 1982). Once on the endangered species list, they were delisted in 2001.

Aleutian cackling geese
Photo by Mike Peters

White goose populations of lesser snow (snow) and Ross's geese in California have remained relatively stable to slightly increasing in recent years. The Pacific Flyway's portion of the populations have not shown the dramatic increases in white geese that have occurred in most other North American white goose populations (USFWS 2001).

Despite both declines in waterfowl numbers and habitat, millions of waterfowl still concentrate in the Central Valley of California. The primary waterfowl use of the Refuges is by wintering ducks and geese, accounting for over 95 percent of all waterfowl use-days. Ducks breeding in areas to the north (mostly from Alaska and Western Canada) start migrating into the Sacramento Valley in August, and by early October, hundreds of thousands of both ducks and geese are present. Many birds arrive via the Klamath Basin, one of the most important migration staging areas in the Pacific Flyway (Gilmer et al. 2004).

Presently, peak wintering numbers in California occur during late November through January, when 3-4 million ducks and over a million geese have been present in recent years (USFWS 1989-2007). For perspective, the four Refuges together have an average peak of over one million ducks and 300,000 geese. In some years, the four Refuges can exceed 1.5 million ducks and 300,000 geese (USFWS 1989-2007). The most common wintering duck species include northern pintail, mallard, American wigeon, green-winged teal, gadwall, northern shoveler, and ring-necked duck (Table 7). The most common goose species include lesser snow, Ross's, and Pacific and tule greater white-fronted geese. At certain times of the fall and winter, the majority of the Flyway's portion of the population of Pacific greater white-fronted geese will be present on the four Refuges (USFWS 1985-2006; Trost 2006). Sacramento, Delevan, and Colusa Refuges comprise the core wintering area for tule greater white-fronted geese (Hobbs 1999).

Table 7. Regular waterfowl survey summary, early December, 2006.

Refuge	Sacramento	Delevan	Colusa	Sutter	TOTALS
Coot	36,310	23,080	6,589	6,920	72,899
White-fronted goose	29,836	32,410	15,980	29,800	108,026
Snow/Ross's goose	147,460	78,600	39,940	68,830	334,830
Western Canada goose	30	160	0	0	190
Cackling Canada goose	8	0	222	0	230
Total Geese	**177,334**	**111,170**	**56,142**	**98,630**	**443,276**
Mallard	42,576	28,928	5,955	11,265	88,724
Pintail	426,060	169,780	32,478	41,540	669,858
Gadwall	38,919	30,354	8,574	3,615	81,462
Wigeon	50,595	59,810	24,426	8,725	143,556
Green-winged teal	64,700	94,450	14,480	4,784	178,414
Cinnamon teal	616	255	30	0	901
N. shoveler	34,899	37,555	17,446	6,151	96,051
Wood duck	2	0	64	352	418
Total Dabbling Ducks	**658,367**	**421,132**	**103,453**	**76,432**	**1,259,384**
Ring-necked duck	13,880	6,020	1,874	276	22,050
Ruddy duck	7,360	4,950	39	280	12,629
Bufflehead	273	390	184	191	1,038
Canvasback	30	0	0	0	30
other divers	0	0	0	2	2
Total Diving Ducks	**21,543**	**11,360**	**2,097**	**749**	**35,749**
Total All Ducks	**679,910**	**432,492**	**105,550**	**77,181**	**1,295,133**

Waterfowl use of the Refuges' habitat varies by species and includes many other factors such as water depth, ratio of open water to emergent vegetation, food availability, access to loafing sites, level of human disturbance, and tradition. Over 95 percent of the waterfowl that occur on the Refuges are dabbling ducks and geese, which all prefer relatively shallow water. Only one to five percent are diving duck species, which prefer deeper water. Pintail, wigeon, green-winged teal, shovelers, and other species prefer more open water, whereas mallards and gadwall will use wetlands with denser cover (Heitmeyer and Raveling 1988).

Tule greater white-fronted goose
Photo by Mike Peters

Seasonally flooded wetlands (including watergrass units) contain abundant seeds and other vegetative food items (leaves, stems, tubers, etc.) produced from moist soil, and other aquatic plants, and invertebrates (insects, spiders, crustaceans, etc.). They are diverse in the amount and distribution of emergent vegetation (bulrushes, cattails) they provide, and also contain bare islands, levees, and open shorelines that provide excellent waterfowl loafing sites. Not surprisingly, the majority of wintering waterfowl select this habitat type above all other managed wetlands (Table 8). Waterfowl survey data collected on the Complex indicates that SFW can support up to three times the densities of semi-permanent wetlands and ten times that of permanent wetlands (M. Wolder, unpublished data).

Vernal pools are also heavily used once they fill during the winter and spring, especially by mallards, wigeon, green-winged teal and shovelers (Bogiatto and Karnegis 2006; Silveira 1998). In addition, geese and wigeon will readily forage in alkali meadows and short grass uplands as soon as green browse is available in the fall (Silveira 1998; USFWS 1989-2007).

Table 8. Average duck densities (per acre with sample size in parentheses) by habitat type on managed wetlands at Sacramento Refuge Complex.

	Sacramento	Delevan	Colusa	Sutter
Permanent Pond	18.7 (272)	11.6 (105)	6.0 (408)	6.5 (13)
Summer Water	42.9 (536)	30.6 (325)	16.7 (246)	28.7 (210)
Watergrass	81.8 (358)	55.1 (225)	26.4 (71)	50.0 (144)
Seasonally Flooded Wetland	46.8 (4192)	41.3 (1909)	23.0 (2345)	42.3 (960)

The level of human activity plays a significant role in the distribution of waterfowl on the Refuges. Disturbance from auto tour routes, walking trails, hunting areas, and adjacent off-refuge activities can significantly affect bird use patterns (Purdy et al. 1987; Heitmeyer and Raveling 1988; Dahlgren and Korschgen 1992; Wolder 1993). For example, green-winged teal are particularly sensitive to human disturbance. Despite their overall significant numbers, they are very uncommon along auto tours and walking trails, tending to choose the most isolated areas within the sanctuaries (closed areas). Conversely, shovelers are less sensitive to disturbance relative to other species, and are more common in disturbed areas, including hunting areas (Heitmeyer and Raveling 1988). Other species tend to fall in the middle in terms of their sensitivity to human disturbance. Pintails, the most common waterfowl species on the Refuges, also showed strong differences in use patterns among units adjacent to auto tour routes, hunting units, and undisturbed units (Wolder 1993). Although hunting areas are readily used before and after the waterfowl hunting season, daytime use is much reduced during the hunting season compared to other Refuge units (Heitmeyer and Raveling 1988; Wolder 1993). Waterfowl compensate for this, in part, by feeding at night in areas (i.e. hunting areas both on and off-Refuge) that are disturbed during the day. Waterfowl also tend to use denser habitats during the hunting season, presumably because they feel more secure due to the heavier vegetation that buffers both the sight and sounds of human activity (Heitmeyer and Raveling 1988; Wolder 1993).

Snow geese
Photo by Steve Emmons

Tradition is a somewhat subjective factor of habitat use, and is most apparent with geese, especially with roosting sites. Some areas are used year after year by species, such as cackling geese and tule greater white-fronted geese.

6.2. Breeding Waterfowl

A small percentage of ducks remain through the spring and summer months to nest. An estimated 2,000 to 3,000 ducks are produced on the Refuges annually. Overall, the Central Valley is a significant breeding area for mallards (McLandress et al. 1996). In addition to production, wetlands on the Refuges also provide important post-breeding waterfowl molting areas (Yarris et al. 1994).

Breeding waterfowl include (in order of most common to least common) mallard, cinnamon teal, gadwall, wood duck, western Canada goose, redhead, and ruddy duck. These species nest in a variety of uplands and wetlands. Most are ground-nesting species that nest in grasslands, drawn-down seasonal wetlands, or islands in semi-permanent and permanent wetlands. Redheads and ruddy ducks nest over water in permanent or semi-permanent wetlands. Wood ducks are exclusively cavity nesters, most nesting in human-made wood duck boxes located along wooded canals or wetlands. Broods and molting birds of all species are primarily supported by semi-permanent and permanent wetlands. Some early broods take advantage of seasonal wetlands that are still in their spring drawdown phase.

6.3. Shorebirds

Shorebirds are present on the Refuges year-round, but as with most other migratory waterbirds, the greatest numbers are present during the non-breeding portions of the year. Surveys of the Central Valley in the mid-1990s indicated that the greatest numbers occur during winter and spring, when they are using a combination of flooded harvested rice fields and managed wetlands (Shuford et al. 1998). Shorebirds typically peak on the Refuges during spring as they pass

through to their northern breeding grounds in the arctic tundra of Alaska. During this period, many of the Refuges' seasonal wetlands and vernal pools provide abundant shallow habitat that the birds use to feed on aquatic insects and other invertebrates. During dry years, the Refuges can be particularly important for spring migrants based on habitat conditions in other parts of the Valley (Wolder et al. 1999). The most common migrants and wintering birds include western and least sandpipers, dunlin, long-billed dowitchers, long-billed curlews, and greater yellowlegs. A few birds will stay through the spring and early summer to breed on the Refuges, including killdeer, black-necked stilts, and American avocets.

Black-necked stilt and long-billed dowitchers.
Photo by Mike Peters

6.4. Wading/diving birds

Many wading and diving birds are present on the Refuges year-round, utilizing several different habitats for foraging, roosting, and nesting. Great blue heron, great egret, and double-crested cormorant rookeries exist in riparian forests at Sacramento, Colusa, and Sutter Refuges. Other rookeries occur in summer wetlands, where species including white-faced ibis, snowy and cattle egrets, and black-crowned night-herons nest in hard-stemmed bulrush and cattail patches. Other year-round species include American and least bitterns, green herons, Virginia rails, soras, common moorhens, American coots, and pied-billed and western grebes. American white pelicans can be present in significant numbers, but they do not breed in the Central Valley.

White-faced ibis have been of particular interest because of their relatively recent increases in abundance. Extremely rare in the Sacramento Valley as of the 1970s, the white-faced ibis has increased dramatically, with significant breeding colonies and wintering birds on the Refuges.

6.5. Gulls/terns

Ring-billed and herring gulls are the most common gulls, occurring primarily during fall and into spring. Herring gulls can congregate on

the Refuges during winter waterfowl disease outbreaks, when they function as major scavengers. Forster's and Caspian terns are often seen migrating in small numbers during the spring and fall. Black terns are present during the summer and nest in some areas of the Valley, including occasionally on Refuge wetlands.

6.6. Birds of Prey

Wide varieties of raptor species use the Refuges throughout the year. Breeding species include red-tailed, red-shouldered, and Swainson's hawks, northern harriers, American kestrels, and common barn and great horned owls. Notably, a pair of golden eagles has nested at Sacramento Refuge annually since 1997.

As with most of the other bird groups, overall raptor abundance is greatest in the winter. Raptors gather because of the abundant prey base of waterfowl, other wintering birds, and rodents. With the exception of Swainson's hawks, all of the breeding species are also present during the winter in greater numbers, especially red-tailed hawks and northern harriers. Other regular wintering species include American bald eagle, turkey vulture, white-tailed kite, peregrine falcon, and Cooper's hawks. Burrowing owls are a species of concern on the Refuges, as their numbers on the Complex have significantly decreased in the past 30 years.

6.7. Game birds

Upland game birds occupy various habitats on the Refuges. California quail, ring-necked pheasants, and wild turkeys are resident species that use a variety of grassland, riparian, and wetland habitats throughout the year. Grasslands are used for nesting and foraging, and riparian forest and wetlands provide roosting sites and escape cover. Mourning doves and Wilson's snipe (a shorebird) are technically "migratory birds," but are also classified as upland game birds in the California hunting regulations. Mourning doves occur year-round, as a common nester in riparian forest during the spring and summer, and a less common winter resident. Wilson's snipe is primarily a migrant species and is most common in fall through spring in shallow wetlands. The only game birds hunted on the Refuges are snipe and pheasant.

Wilson's snipe
Photo by Steve Emmons

6.8. Other Landbirds

The Refuges provide a variety of habitats for a great diversity of migratory and resident landbirds (Gilmer et al. 1998) (Appendix K). Habitat diversity, structural complexity, and proximity to wetlands are important habitat features. The Sacramento Valley is an important migration corridor that provides stopover resting and feeding habitat for landbirds that breed in the nearby foothills and mountains. It also contains important breeding and wintering area for a variety of migratory and resident songbirds and other landbirds. Many of these species are priority or focal species in conservation plans or on Federal or State priority species lists (Table 9, Appendix K).

One particular species of concern is the tricolored blackbird, a mainly California endemic species. These colonial birds nest in wetlands on the Refuges and feed in grasslands and seasonal wetlands. They will readily use upland areas grazed by livestock. Colonies periodically occur on all the Refuges and, in some years, Delevan Refuge has supported the largest nesting colonies in the state (Beedy et al. 1991; Hamilton 2004). Tricolors are likely itinerant breeders, with birds breeding in the San Joaquin Valley early in the season around April, then some moving up to the Sacramento Valley around late May to early June for another attempt (Hamilton 1998).

Tri-colored blackbird
Photo by Steve Emmons

Non-native European starlings and house sparrows are common and often compete with native species for nesting sites. In addition, several native North American species whose populations have grown or expanded considerably, including American crow, common raven, and great-tailed grackle, are of concern because of their potential predation impacts on other species.

6.9. Mammals

Many mammalian species are year-round residents of the Refuges. Wetlands and associated waterways support beaver, mink, river otter, and non-native muskrats. Other native species include the broad-footed mole, ornate shrew, big brown bat, Brazilian free-tailed bat, California myotis, Townsend's big-eared bat, black-tailed jackrabbit, desert cottontail, California vole, deer mouse, Botta's pocket gopher, California ground squirrel, western harvest mouse, coyote, long-tailed weasel, raccoon, striped skunk, and black-tailed deer. Non-native species include the Virginia opossum, black rat, Norway rat, house mouse, and feral house cat.

6.10. Amphibians and Reptiles

Reptiles are common residents on the Refuges, and include common and giant garter snakes, gopher snake, western yellow-bellied racer, California kingsnake, western fence lizard, western pond turtle, and red-eared slider (a non-native species). These reptiles mostly occur in upland habitats; however, the giant garter snake and western pond turtle are wetland-dependent species and occur commonly in permanent wetlands and canals. The Pacific treefrog and American bullfrog (a non-native species) are the only amphibians known to occur on the Refuges.

Western pond turtles
Photo by Mike Peters

6.11. Fish

Fish species occur at the Refuges throughout the water distribution system, which includes several creeks (Logan, Stone Corral, Hunter's), the Colusa Basin Drain, east and west Sutter Bypass canals, and many smaller water supply and drainage ditches. These areas are all part of the Sacramento River system and share many of the same species (Appendix K). Most fish are non-native warm water resident species. Native anadromous fish include steelhead and four distinct runs of Chinook salmon. Three of the four Chinook salmon runs are considered unique Evolutionary Significant Units (ESU). These include the Sacramento River winter-run ESU, Central Valley spring-run ESU, and Central Valley fall-run and late-fall-run ESU Chinook salmon. The Central Valley ESU steelhead is also a unique race. Anadromous fish are migratory, using the open ocean, bays, estuaries, deltas, main river channels, floodplains, and tributaries.

Anadromous fish spawn in freshwater environments and spend their adult life in marine environments.

During periods of high flows in the Sutter Bypass, large numbers of Chinook salmon and steelhead can use Sutter Refuge. Adult Chinook salmon and steelhead that spawn in Butte Creek pass through the Sutter Bypass to their spawning area in upper Butte Creek, while migrating juveniles pass through the Bypass to the Pacific Ocean. These fish typically pass through the Bypass during high water events within the east and west borrow channels, which are adjacent to Sutter Refuge. The Refuge maintains adequate flows of water through the wetland units within the Bypass for migrating juvenile salmonids during periods when these fish may be present.

The above fish resources support a wide array of fish-eating birds and mammals, including pelicans, grebes, cormorants, bald eagles, osprey, and river otters.

6.12. Invertebrates

Invertebrates present on the Refuges are an important resource based on their contribution to biotic diversity and their vital function in the food chain for many fish and wildlife species. They occur in all habitat types, both aquatic and terrestrial. Some are abundant such as many species of midges, while others are quite rare, such as some vernal pool shrimp. A variety of endemic species occurs in vernal pool/alkali meadow habitats in association with endemic plant species.

In combination with seeds and other vegetation, aquatic invertebrates are an essential part of many waterbird diets at various times of the year, as they provide a balance of amino and fatty acids to facilitate fat and protein storage (Euliss and Harris 1987; Miller 1987; Heitmeyer and Raveling 1988). Invertebrates provide energy for migration, protein to replace molted feathers, and calcium for the production of eggs. Central Valley wetlands support a wide variety of aquatic invertebrates, including water fleas, snails, clams, dragonflies, damselflies, water boatmen, backswimmers, beetles, midges, mosquitoes, worms, clams, snails, crayfish, fairy shrimp, and various species of zooplankton (Severson 1987; Sefchick 1992; Lawler et al. 1997; Silveira 1998; Eriksen and Belk 1999). While many of these species larvae occur in the water column or sediment in wetlands, the adult stages are aerial and an important food source for landbirds and mammals, as well (i.e. swallows, flycatchers, and bats).

Terrestrial invertebrates are also an important food base for many migratory and resident bird species, and include numerous species of grasshoppers, beetles, butterflies, moths, ants, spiders, and other insects. In addition, many of these invertebrates play key roles in plant pollination, including many rare and endemic species on the Refuges (Thorpe and Leong 1995).

Monarch butterfly caterpillar
Photo by Joe Silveria

6.13. Threatened and Endangered Species

The Refuges provide breeding, rearing, migratory and/or wintering habitat for a number of Federal and State threatened and endangered species and species of special status. Listed species are presented in Table 9 and are summarized below.

6.13.1. Palmate-bracted Bird's-beak

Palmate-bracted bird's-beak (Federal and State-listed endangered species) is an annual herb in the snapdragon family. The plants are 4-12 inches tall and highly branched. The stems and leaves are grayish green with small pale whitish flowers, ½-inch to 1 inch long, are arranged in dense clusters (spikes) and densely surrounded by herbaceous leaf-like bracts. Like other *Cordylanthus* species, the petals are divided into two lips. The upper one is shaped like a bird's-beak, leading to the common name of the genus. Seedlings grow in late March or April. Flowers bloom from late spring through summer. Palmate-bracted bird's-beak is partially parasitic on the roots of other plants, including salt grass.

Palmate-bracted bird's-beak grows on seasonally flooded, saline-alkali soils in lowland plains and basins at elevations of less than 500 feet (Mason 1957). Within these areas, it grows primarily along the edges of channels, drainages, and vernal pools with a few individuals scattered in seasonally wet depressions, alkali scalds (barren areas with a surface crust of salts) and grassy areas.

Table 9. Federal and State listed species occurring or potentially occurring at Sacramento, Delevan, Colusa, and Sutter Refuges.

Species		Status		Habitat Type	Refuge Occurrence
		State	Federal		
Plants					
Palmate-bracted bird's-beak	*Cordylanthus palmatus*	CE	FE	vernal pool, alkali meadow	**SA, D, C**
Hairy Orcutt grass	*Orcuttia pilosa*	CE	FE	vernal pool	**SA,** D, C
Greene's tuctoria	*Tuctoria greenei*		FE	vernal pool	**SA**, D, C
Hoover's spurge	*Chamaesyce hooveri*		FT	vernal pool	**SA,** D, C
Colusa grass	*Neostapfia colusana*	CE	FT	vernal pool	extirpated
Invertebrates					
Conservancy fairy shrimp	*Branchinecta conservation*		FE	vernal pool	**SA,** D,C
Vernal pool fairy shrimp	*Branchinecta lynchi*		FT	vernal pool	**SA,** D,C
Vernal pool tadpole shrimp	*Lepidurus packardi*		FE	vernal pool	**SA, D**,C
Fish					
Chinook salmon, Central Valley Spring.-run	*Oncorhynchus tshawytscha*	CT	FT	riverine floodplain	**SU**
Chinook salmon, Sacramento River Winter-run	*Oncorhynchus tshawytscha*	CE	FE	riverine floodplain	**SU**
Chinook salmon, Central Valley Fall/late Fall-run	*Oncorhynchus tshawytscha*		CS	riverine floodplain	**SU**
Steelhead, Central Valley ESU	*Oncorhynchus mykiss*		FT	riverine floodplain	**SU**
Amphibians & Reptiles					
Giant garter snake	*Thamnophis gigas*	CT	FT	wetlands, uplands	All
Birds					
Swainson's hawk	*Buteo swainsoni*	CT		riparian forest, grasslands	All
Greater sandhill crane	*Grus canadensis tabida*	CT		seasonal wetlands	All
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	CE	CS	riparian forest	**SU**
Willow flycatcher	*Empidonax traillii*	CE		riparian forest	All

Status Key: State of California: CE - State-listed, Endangered, CT - State-listed, Threatened
Federal: FE - Federal-listed, Endangered, FT - Federal-listed, Threatened, CS – Candidate Species
Refuge Occurrence: SA – Sacramento Refuge, D – Delevan Refuge, C – Colusa Refuge, SU – Sutter Refuge
Bold indicates species has been observed on the Refuge and non-bold indicates suitable habitat is present.

Historically, the species is known from scattered locations in Fresno and Madera counties in the San Joaquin Valley, San Joaquin, Yolo, and Colusa counties in the Sacramento Valley and the Livermore Valley area of Alameda County. It is currently known to occur in seven locations in the Sacramento, Livermore and San Joaquin valleys. These include Sacramento, Delevan, and Colusa Refuges (Silveira 1992-2006a), the Woodland area, Springtown Alkali Sink near Livermore, western Madera County, and the combined Alkali Sink Ecological Reserve and Mendota Wildlife Management Area. The total occupied surface area over the seven locations is estimated at less than 741 acres (CFDG 2005a). Palmate-bracted bird's-beak has been included in one of the first ecosystem recovery plans by the Service (USFWS 1998a). Populations on Delevan and Colusa Refuges currently comprise the majority of the entire population of this species.

6.13.2. Hairy Orcutt Grass

Hairy Orcutt grass (Federal and State-listed endangered species) inhabits vernal pools in rolling topography on remnant alluvial fans and stream terraces in the Central Valley. It is found on both acidic and saline-alkaline soils. It is a small (6-8 inches tall) annual in the grass family. Foliage is grayish with soft, straight hairs. Hairy Orcutt grass flowers from May through September.

The historical range includes the eastern margins of Sacramento and San Joaquin Valleys from Tehama County south to Stanislaus County and through Merced and Madera counties. Only 27 of 40 historically known populations exist, including a new population in Merced County found in 2001 and a transplant population (CDFG 2005a). More than one third of the remaining populations occur in Tehama County. Others are in Butte, Glenn, Madera and Stanislaus counties. Populations of hairy Orcutt grass are found at the Sacramento Refuge in Glenn County (Silveira 1992-2006b). Conversion of vernal pool habitat to irrigated agriculture, vineyards, or orchards, or to urban uses has been the primary factor leading to the decline of this species (CDFG 2005a; USFWS 2005a).

Hairy Orcutt grass
Photo by Joe Silveria

6.13.3. Greene's Tuctoria

Greene's tuctoria (Federal-listed endangered species), which is also known as Greene's Orcutt grass, is a small, tufted annual in the grass family. The plant has several to many stems 2 to 6 inches tall, each ending in a spike-like inflorescence that may be partly enfolded in the upper leaf.

The genus *Tuctoria* is distinguished from the closely related Orcutt grasses, by the spiral arrangement of the spikelets (flowers) and other characteristics of its flower parts.

Greene's tuctoria is restricted to small or shallow vernal pools or the early drying sections of large, deep vernal pools in the Central Valley. Its historical range included parts of Shasta, Tehama and Butte counties in the northern Sacramento Valley, and extended from San Joaquin County to Tulare County in the San Joaquin Valley. About half of the approximately 40 known occurrences of Greene's tuctoria have been extirpated through habitat conversion to irrigated agriculture and intensive cattle grazing (CDFG 2005a). The species apparently no longer occurs in Fresno, Madera, San Joaquin, Stanislaus, and Tulare counties. The remaining populations are in Shasta, southern Tehama, Butte, Glenn, and eastern Merced counties (USFWS 2005a). Populations of Green's tuctoria are found on Sacramento Refuge. Refuge surveys (Silveira 1992-2006b) have not detected Greene's tuctoria since 1996, a trend found throughout the species range.

6.13.4. Hoover's Spurge

Hoover's spurge (Federal-listed threatened species), also known as Hoover's sanmat, is a prostrate, tap-rooted, annual herb in the spurge family. It forms mats from a few inches to a few feet across. The flowering structure in Hoover's spurge has petal-like glands that are red to olive in color. Blooms appear in July. This species is readily distinguished from other species of *Chamaesyce* by characteristics of growth habit, plant color, and leaf shape.

Hoover's spurge grows in relatively large, deep vernal pools among the rolling hills, remnant alluvial fans, and depositional stream terraces at the base of the Sierra Nevada foothills. It tends to occur where competition from other species has been reduced by prolonged seasonal inundation or other factors. The main remaining area of concentration for Hoover's spurge is in the northeastern Sacramento Valley. The Vina Plains of Tehama and Butte counties contains 14 (53.8 percent) of the 26 known extant occurrences (USFWS 2005a). One other site in the same region is near Chico in Butte County. Seven of the extant occurrences are in the Southern Sierra Foothills, including five in the Visalia-Yettem area of Tulare County and two in the Hickman-La Grange area of Stanislaus County. Three other occurrences are on the Sacramento Refuge in Glenn County (Silveira

1992-2006b). The one other extant occurrence is on the Bert Crane Ranch in Merced County (USFWS 2005a).

6.13.5. Colusa Grass

This species has apparently been extirpated from Colusa County (USFWS 2005a). Historic accounts of this species (and its name) indicate that it likely occurred on or near Colusa, Delevan, and Sacramento Refuges. As a result, there is a possibility Colusa Grass could potentially still be present in small amounts. Monitoring of other rare endemic plant species on the Refuges indicate that there is a significant amount of variability in their occurrence from year to year and, in fact, certain species may not occur in some years or for a period of years (Silveira 1992-2006b).

6.13.6. Conservancy Fairy Shrimp

Conservancy fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp occur exclusively in vernal pool habitats that are flooded with rainwater. They occur as eggs in summer and fall dry periods, hatching and growing into breeding adults during their wet cycle following rain during winter and spring. Vernal pool habitat occurs at Sacramento, Delevan, and Colusa Refuges.

The Conservancy fairy shrimp (Federal-listed endangered species) is a small crustacean that ranges in size from about ½ to one inch long. They have delicate elongate bodies, large stalked compound eyes, no carapaces, and eleven pairs of swimming legs. Conservancy fairy shrimp inhabit rather large, cool-water vernal pools with moderately turbid water (Eriksen and Belk 1999). The pools generally last until June. Female fairy shrimp carry their eggs in a ventral brood sac. The eggs are either dropped to the pool bottom or remain in the brood sac until the mother dies and sinks. When the pool dries out, so do the eggs. They remain in the dry pool bed until rains and other environmental stimuli trigger them to hatch. Resting fairy shrimp eggs are known as cysts. They are capable of withstanding heat, cold and prolonged desiccation. When the pools refill, some, but not all, of the cysts may hatch. The cyst bank in the soil may contain cysts from several years of breeding. Hatching can begin within the same week that a pool starts to fill. Average time to maturity is forty-nine days. In warmer pools, it can be as little as nineteen days (Eriksen and Belk 1999).

The Conservancy fairy shrimp is currently known from several disjunct populations: the Vina Plains in Tehama County, south of Chico in Butte County; the Jepson Prairie Preserve and surrounding area in Solano County; Sacramento Refuge in Glenn County (Silveira 2005); Mapes Ranch west of Modesto, San Luis Refuge, and the Haystack Mountain/Yosemite Lake area in Merced County; and two locations on the Los Padres National Forest in Ventura County (USFWS 2005a).

6.13.7. Vernal Pool Fairy Shrimp

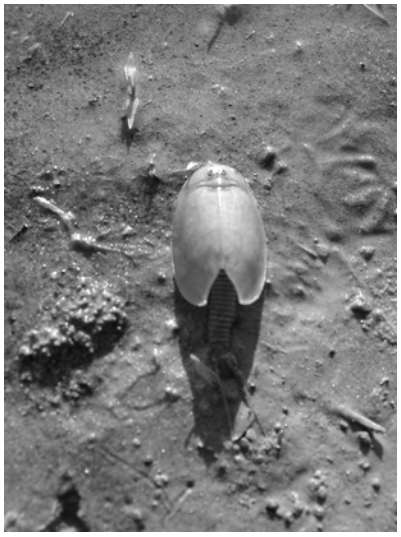
The vernal pool fairy shrimp (Federal-listed threatened species) is a small crustacean that occupies a variety of different vernal pool habitats, from small, clear, sandstone rock pools to large, turbid, alkaline, grassland valley floor pools. Although the species has been collected from large vernal pools, including one exceeding 25 acres, it tends to occur in smaller pools. It is most frequently found in pools measuring less than 0.05 acre. These are most commonly in grass or mud bottomed swales, or basalt flow depression pools in unplowed grasslands. Vernal pool fairy shrimp have been collected from early December to early May.

The vernal pool fairy shrimp is widespread but not abundant. Known populations extend from Stillwater Plain in Tehama County through most of the length of the Central Valley to Pixley National Wildlife Refuge in Tulare County. Along the central coast, they range from northern Solano County to Pinnacles National Monument in San Benito County. Four additional, disjunct populations exist: near Soda Lake in San Luis Obispo County; in the mountain grasslands of northern Santa Barbara County; in the Santa Rosa Plateau in Riverside County; and near Rancho California in Riverside County. Vernal pool fairy shrimp are found on Sacramento Refuge (Silveira 2005).

The vernal pool fairy shrimp was identified relatively recently, in 1990. There is little information on its historical range. However, since it is currently known to occur in a wide range of vernal pool habitats, the historic distribution may have coincided with the historic distribution of Central Valley and Southern California vernal pools (USFWS 2005a).

6.13.8. Vernal Pool Tadpole Shrimp

The vernal pool tadpole shrimp (Federal-listed endangered species) is a small crustacean with compound eyes, a large shield-like carapace (shell) that covers most of the body, and a pair of long cercopods (appendages) at the end of the last abdominal segment. Vernal pool tadpole shrimp adults reach a length of 2 inches in length. They have about 35 pairs of legs and two long cercopods. This species superficially resembles the rice field tadpole shrimp.



Vernal pool tadpole shrimp
Photo by Joe Silveira

Tadpole shrimp climb or scramble over objects, as well as plowing along or within bottom sediments. Their diet consists of organic debris and living organisms, such as fairy shrimp and other invertebrates. This animal inhabits vernal pools containing clear to highly turbid water, ranging in size from 54 square feet in the former Mather Air Force Base area of Sacramento County, to the 89-acre Olcott Lake at Jepson Prairie in Solano County (USFWS 2005a).

The life history of the vernal pool tadpole shrimp is linked to the seasonal cycle of the vernal pool. After winter rainwater fills the pool, the population is reestablished from cysts that lie dormant in the dry pool sediments. Sexually mature adults have been observed in vernal pools three to four weeks after the pools had filled. Some cysts hatch immediately and the others remain dormant in the soil to hatch during later rainy seasons.

The vernal pool tadpole shrimp is known from eighteen populations in the Central Valley, ranging from east of Redding in Shasta County south to Tulare County, and from a single vernal pool complex on the San Francisco Bay Refuge in the City of Fremont, Alameda County (USFWS 2005a). Vernal pool tadpole shrimp are found on Sacramento Refuge (Silveira 2005).

Sacramento Refuge is a Priority 1 recovery area for vernal pool tadpole shrimp, vernal pool fairy shrimp, Conservancy fairy shrimp, Hoover's spurge, Green's tuctoria, and hairy Orcutt grass, which are all included in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005a).

6.13.9. Chinook Salmon, Sacramento River Winter-run ESU

Chinook salmon, the Sacramento River winter-run ESU (Federal and State-listed endangered species), only occurs in the Sacramento River watershed in California and most spawning is limited to the main stem of the Sacramento River. Adult salmon leave the ocean and migrate through the Sacramento-San Joaquin Delta and upstream into the Sacramento River from December through July. Downstream migration of juvenile winter-run Chinook salmon occurs from November through May. They rear as fry along the entire Sacramento River and also migrate past the Refuge as smolts. Winter-run Chinook salmon can rear in the following areas on the Sacramento River: above Red Bluff Diversion Dam (moving downstream as smolts), and probably in the lower river between river mile 70 and 164 (moving downstream as fry). Water temperatures determine juvenile rearing locations and river conditions strongly influence movement. Critical Habitat for the Sacramento River winter-run Chinook salmon was designated June 16, 1993 (58 CFR 33212, June 16, 1993). This species occurs on the Complex in Butte Creek, the east and west Sutter Bypass channels, and the Sacramento River. Winter-run Chinook salmon are monitored by the CDFG (2005b).

6.13.10. Chinook salmon, Central Valley Spring-run ESU

Chinook salmon, the Central Valley spring-run ESU (Federal and State-listed threatened species), occurs in the main stem of the Sacramento River and the Mill Creek, Deer Creek, Big Chico Creek, and Butte Creek tributaries. Adult salmon leave the ocean and migrate through the Sacramento-San Joaquin Delta, upstream into the Sacramento River from March through September. Downstream migration of juvenile spring-run Chinook salmon occurs from March through June, while yearlings move downstream from November through April. Most spawning occurs in headwater tributary streams. Critical habitat designation for this ESU is under development. This species occurs in the Butte Creek system, including the east and west Sutter Bypass channels. Spring-run Chinook salmon are monitored by the CDFG (2005b).

6.13.11. Chinook salmon, Central Valley Fall-run ESU and Late-fall-run ESU

Chinook salmon, the Central Valley fall-run ESU and late-fall-run ESU (Federal candidate species), occur in the main stem and tributaries of the Sacramento River. Adult fall-run salmon leave the ocean, migrate through the Sacramento-San Joaquin Delta, upstream into the Sacramento River from July through December, and spawn from October through December. Spawning occurs on the main stem of the Sacramento River, including below the Red Bluff Diversion Dam.

Late-fall-run Chinook salmon occur on the main stem of the Sacramento River. Adult salmon leave the ocean, migrate through the Sacramento-San Joaquin Delta, upstream into the Sacramento River from October through April, and spawn from January through April. Spawning occurs above the Red Bluff Diversion Dam and lower tributaries of the middle and upper Sacramento River. This species occurs in the Butte Creek system, including the east and west Sutter Bypass channels. Fall-run and Late-fall-run Chinook salmon are monitored by the CDFG (2005b).

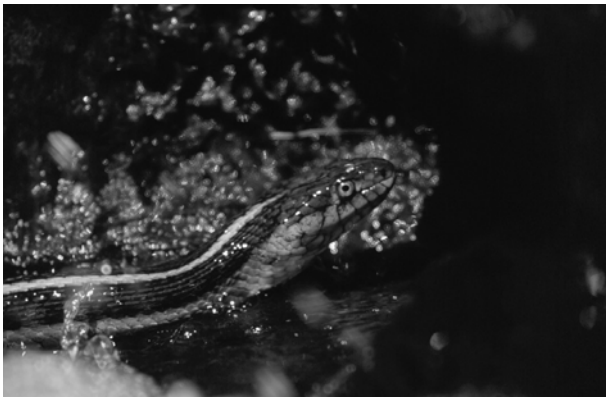
6.13.12. Steelhead, Central Valley ESU

Steelhead, the Central Valley ESU (Federal-listed threatened species), is an anadromous form of rainbow trout. This species has traditionally supported a major sport fishery in the Sacramento River system. Their historical range in the Central Valley has been reduced by dams and water diversions that now restrict the species to the lower portions of major rivers, where habitat is less favorable for steelhead spawning and rearing. Steelheads use the Sacramento River as a migration corridor to and from spawning grounds in the main stem of the river above the Red Bluff Diversion Dam, the tributary streams, and the Coleman National Fish Hatchery. They are present in the Sacramento River year-round, either as smolts migrating downstream or adults migrating upstream or downstream. Upstream migration begins in July, peaks in the fall, and continues

through February or March. Most spawning occurs from January through March. Juvenile migration generally occurs during the spring and early summer after at least one year of rearing in upstream areas. Populations have greatly declined over much of the species' range, including the Sacramento River basin, due to blockage of upstream migration by dams and flood control projects, agricultural and municipal diversions, harmful temperatures in the Sacramento River, reduced availability of spawning gravels, and toxic discharges. Designation of river reaches as Critical Habitat is being considered for this ESU. This species occurs in the Butte Creek system, including the east and west Sutter Bypass channels. Steelheads are monitored by the CDFG (2005b).

6.13.13. Giant Garter Snake

The giant garter snake (GGS) (Federal-listed threatened species and State-listed threatened species) is an endemic species to the valley floors of the Sacramento and San Joaquin valleys (USFWS 1999a). Although the boundaries of its original distribution are uncertain, giant garter snakes probably historically occurred from Butte County in the north, southward to Buena Vista Lake in Kern County (USFWS 1999a). The present distribution is from Chico to central Fresno County. Loss, degradation, and fragmentation of habitat are the primary threats to the giant garter snake. Conversion of wetlands for agriculture and urban and industrial development has resulted in the loss of more than 90 percent of suitable habitat for this species in the Central Valley (CDFG 2005a).



Giant garter snake
Photo by Gary Kramer

The GGS requires freshwater wetlands, such as marshes and low gradient streams. Permanent wetlands are of particular importance, as they provide habitat over the summer and early fall, when seasonal wetlands are dry. The GGS also inhabits rice fields, irrigation and drainage canals, sloughs, ponds, small lakes, low gradient streams, and adjacent uplands in the Central Valley.

The Service prepared a draft Recovery Plan for this species in 1999. The plan identified four recovery units within the range of the giant

garter snake (Sacramento Valley, Mid-Valley, San Joaquin Valley, and South Valley) and proposes recovery criteria. The recovery criteria include adaptive management and monitoring; successful reintroduction within the historic range of the species; documentation of successful breeding and survivorship in 90 percent of the subpopulations in the recovery units; and maintenance of connectivity between subpopulations.

GGSs occur in significant numbers on all of the Refuges, except for Delevan Refuge. Intensive monitoring efforts by U.S. Geological Survey (USGS) between 1996 and 2005 indicated thriving populations particularly at Colusa and Sacramento Refuges (Carpenter 1999; Wylie et al. 2006). These investigations also documented a positive response from GGS to wetland restoration and management on Colusa Refuge, including increased Refuge populations, decreased exposure to mortality factors, and reduced home range size (Wylie et al. 2006; USFWS 1999a). The size distributions of snakes caught reflect a healthy population of GGSs, with successful recruitment of young.

6.13.14. Swainson's Hawk

Swainson's hawks (State-listed threatened species) breed in North America and winter in Mexico, Central America, and South America. In California, this species may have declined by as much as 90 percent (RHJV 2004). Swainson's hawks were once found throughout the lowland in California and were absent only from the Sierra Nevada, north Coast Ranges and Klamath Mountains, and portions of the desert regions of the State. Today, they are restricted to portions of the Central Valley and Great Basin regions where suitable nesting and foraging habitat is still available (CDFG 2005a).

Approximately 95 percent of the California Swainson's hawks exist in the Central Valley (CDFG and UC Davis 2006). Swainson's hawk nesting and foraging has been documented on or very near all of the Refuges. They nest in trees along riparian corridors, or in isolated trees or small groves, near suitable foraging habitat. Foraging habitat consists of grassland vegetation and short herbaceous croplands.

About 80 percent of the Central Valley population is located in Sacramento, San Joaquin, and Yolo counties. During historical times (ca. 1900), Swainson's hawks may have maintained a population of more than 17,000 pairs. Based on a study conducted in 1994, the statewide population was estimated to be approximately 800 pairs. The current status of the Swainson's hawk in California is declining (CDFG 2005a).

6.13.15. Greater Sandhill Crane

The greater sandhill crane (State-listed threatened species) is the largest of the six subspecies of sandhill cranes. They breed north and east of the Central Valley as far north as British Columbia. The Central Valley is the cranes' primary wintering area, characterized by favorable roost sites and an abundance of cereal grain crops. Rice is used extensively by cranes in the northern Sacramento Valley and corn is the principal food source at most other Central Valley wintering areas. Irrigated pastures are used for feeding and roosting sites throughout the wintering ground. Communal roost sites consisting of open expanses of shallow water are key features of wintering habitat.

Currently, the estimate for greater sandhill cranes within their Pacific Flyway range is between 5,000 and 6,000 (CDFG 2005a). This species continues to experience threats on both wintering and breeding grounds due to agricultural and urban conversion of habitat, predation, human disturbance, and collisions with power lines. Sandhill cranes have been documented on all of the Refuges.

Greater sandhill crane
Photo by Steve Emmons

6.13.16. Western Yellow-Billed Cuckoo

The western yellow-billed cuckoo (Federal candidate species, State-listed threatened species) requires dense, large tracts of riparian woodlands with well-developed understories for breeding. Cuckoo's nest in larger trees, such as Fremont's cottonwoods, located in close proximity to foraging habitat (mixed riparian forest and willow and herbaceous scrublands). Their breeding range in California includes the lower Colorado, Kern, and Sacramento rivers.

The western yellow-billed cuckoo is threatened by loss and degradation of its habitat due to land clearing, fire, flood control projects, surface water diversions and groundwater pumping, and overgrazing by livestock (CDFG 2005a). Such disturbances often foster the establishment of invasive non-native plants, such as tamarisk and giant reed. The resulting fragmentation reduces the size and quality of habitat for the cuckoo.

The current population in California is about 60 to 100 pairs (Halterman et al. 2001). A statewide survey of yellow-billed cuckoos in California conducted during 1986 and 1987 found a total of 30 to 33

pairs and 31 unmated males at nine localities (Laymon and Halterman 1989). The majority of the cuckoos were concentrated along the upper Sacramento River from Red Bluff to Colusa (18 pairs and 19 unmated males) and at the South Fork Kern River (7 pairs and 3 unmated males) (Laymon 1998). Cuckoos were located at Sutter Refuge and other nearby areas during recent surveys conducted in 1999 to 2000 (Isola 2000).

7. Fish and Wildlife Management

Fish and wildlife management on these Refuges is mostly accomplished through habitat management, restoration, and enhancement. Habitat restoration and management can improve the overall health and productivity of fish and wildlife populations by increasing water, food, breeding, staging, winter areas, cover and shelter. Habitat and management needs can be designed to benefit certain target species or, more commonly, multiple species.

7.1. Migratory Bird Management

One of the Refuges' primary purposes is to provide habitat for migratory birds, particularly wintering waterfowl. The habitat management described in the Habitat Section (Section 4) contributes to achieving that purpose. The combination of managed habitat types support annual peaks of 1.5 to 2 million wintering ducks and geese, 50,000 shorebirds during spring migration, a large contingent of raptors, and a variety of other migratory birds. In addition, these habitats support a significant number of breeding and migratory birds, including a variety of waterfowl, grebes, herons, egrets, bitterns, white-faced ibis, coots, moorhens, rails, marsh wrens, blackbirds, and others.

The Refuges coordinates and/or participates in a number of migratory bird surveys and monitoring projects throughout the year. Depending on the survey, these efforts are used for monitoring migratory birds at the Refuge, Valley, State, Pacific Flyway, or national level. They include aerial and ground migratory bird surveys, evaluation of annual arctic goose productivity (age ratios), waterfowl banding, breeding bird surveys, and a number of other special surveys conducted for species of concern (Table 10).

Waterfowl banding
Photo by Mike Carpenter

Table 10. Migratory bird surveys and other monitoring efforts currently conducted by Sacramento Refuge Complex staff[1].

Survey/ Monitoring Effort	Species	Time of Year/ Frequency	Geographic Area	Purpose	Agency Coordination[2]	Product
Regular Wildlife	Most Waterbirds/ Raptors	Sep.-April – monthly; May-August - bimonthly	All Refuges	Monitor Refuge numbers, distribution, and habitat use	USFWS	summary reports
Tule greater white-fronted goose direct	Tule greater white-fronted goose	September/ annual	Sacramento NWR Complex	monitor PF[3] numbers	USFWS, CDFG	summary report
Tule greater white-fronted goose indirect	Tule greater white-fronted goose	Fall-Winter/ annual	Sacramento NWR Complex	monitor PF numbers	USFWS, CDFG	summary report
Special Whitefront	all greater white-fronted geese	October/ annual	Sacramento Valley	monitor PF numbers/ distribution	USFWS, CDFG	summary report
Aleutian Canada Goose	Aleutian Canada goose	Fall-Spring/ annual	Sacramento NWR Complex and vicinity	monitor PF numbers/ distribution	USFWS	summary report
Special Dark Goose	all white-fronted geese, all Canada geese	November/ annual	Sacramento Valley	monitor PF numbers/ distribution	USFWS, CDFG	summary report
Special White Goose	lesser snow goose, Ross's goose	December/ annual	Sacramento Valley	monitor PF numbers/ distribution	USFWS, CDFG	summary report
White Goose Species Composition	lesser snow goose, Ross's goose	December/ once every 3 years	Sacramento Valley	determine proportions of snow and Ross's geese in overall "white goose" population	USFWS, CDFG	summary report
Mid-winter Waterfowl Index	All waterfowl	January/ annual	Sacramento Valley	monitor PF numbers/ distribution	USFWS, CDFG	summary report
Breeding Bird Survey-Orland Route	all birds	June/ annual	specified route in Glenn County	monitor national bird trends	USGS	USGS report
Special surveys for colonial birds	white-faced ibis, herons/egrets, cormorants	May-August/ variable based on occurrence	Sacramento NWR Complex	monitor reproductive effort and success on Refuges	USFWS	summary report
Special Tri-colored Blackbird	tri-colored blackbird	April-August/ no set schedule	Sacramento NWR Complex	monitor state numbers/ distribution, reproductive effort and success	USFWS, CDFG, PRBO, various other participants	state summary report
Arctic Goose Productivity	tule white-fronted goose, pacific white-fronted goose, lesser snow goose, Ross's goose	Fall/ annual	Sacramento NWR Complex and vicinity	monitor annual productivity	USFWS	Flyway Report
Waterfowl Banding	mallard, other waterfowl banded incidentally	summer/ annual	Sacramento NWR Complex	monitor PF survival and harvest rates	USFWS	Flyway Report
Resighting Marked Birds[1]	various waterfowl, shorebirds, or other waterbirds	variable	Sacramento NWR Complex and vicinity	indirect numbers estimates, survival rates, habitat use, migration patterns, etc.	USFWS, USGS, CDFG, CWA, PRBO, various universities, and others	various

[1] Includes surveys that Refuge conducts, coordinates, facilitates, or otherwise participates in.
[2] CDFG = California Department of Fish and Game, USGS = U.S. Geological Survey, CWA = California Waterfowl Association, PRBO = Point Reyes Bird Observatory.
[3] PF = Pacific Flyway.

7.2. Threatened and Endangered Species Management

Sacramento, Delevan, Colusa, and Sutter Refuges provide habitat for a number of threatened, endangered, and sensitive species that occur across a variety of habitat types (Table 9, Appendix K). Management activities for these species and their habitats include vegetation manipulation (i.e. burning, grazing, etc.), population monitoring, and research efforts that are implemented through the same annual habitat management planning (AHMP) process as other biological resources (see Section 4). Any special requirements are considered and documented in the AHMP. Management of these habitats are low-impact, but typically not "hands-off," and often include periodic treatments of burning or grazing, implementation of best management practices (BMPs) to reduce frequency of disturbance, and emphasize the restoration of natural processes, particularly hydrology and the minimization of mechanical soil disturbance.

Certain management activities beneficial to some species or habitats may negatively impact others. Because of the many management activities that regularly occur here, the Complex has consulted with Ecological Services on operations and maintenance activities of the Refuges to ensure that their implementation complies with the Endangered Species Act. The resulting biological opinion stated these activities would not jeopardize the continued existence of any federally-listed endangered or threatened species on the Complex (USFWS 1999d). Part of the opinion recommends BMPs for working in or near sensitive habitats, monitoring, and providing annual reports of activities. As required by Service policy, the Refuges also incorporate State-threatened and endangered species into planning activities.

American avocets
Photo by Steve Emmons

7.3. Game Management

Game species commonly occurring on the Refuges include wild turkeys, ring-necked pheasants, various waterfowl species, and Wilson's snipe. The only game species hunted on the Refuges are waterfowl, snipe, and pheasant. Other than waterfowl, game species, are not managed for explicitly. However, upland game species receive incidental benefits from the habitats that are managed for other priority Refuge resources. For example, uplands, seasonal marshes, and summer wetlands all contribute to nesting cover for upland game birds. Well-distributed summer wetlands (semi-permanent and permanent) provide essential water sources during summer months, when the Refuges are relatively dry. Pheasant brood production is monitored annually on Sacramento, Delevan, and Colusa Refuges. Results provide an index to track the production of pheasants and other ground nesting birds, and can be related back to harvest information from Refuge hunting areas. Turkeys are monitored through regular wildlife surveys.

Ring-necked pheasant
Photo by Steve Emmons

7.4. Monitoring, Research, and Investigations

Monitoring and research projects are conducted by refuge biological staff or cooperatively with principle investigators from government agencies, universities, and private conservation organizations. Monitoring and research are the foundation for Refuge management decisions. At the Refuge level, a number of biological surveys are conducted to determine and track the distribution and abundance of biological resources and their use of Refuge habitats. The Refuges' regular wildlife surveys are the cornerstone of these surveys. They are conducted by ground vehicle on standardized routes for each Refuge. Species and numbers of waterfowl and other waterbirds, raptors, and other birds and mammals that can be seen readily are estimated and recorded for each Refuge unit. This level of data collection allows for the evaluation of wildlife use by habitat type, management treatment, and type and level of visitor services (i.e. auto tour, hunt area, walking trail, etc.).

This information is stored, tracked, and analyzed in a database and used to develop annual habitat management plans, where projects designed to rehabilitate, enhance, and restore wildlife habitat are identified, prioritized, and project implementation is tracked and management actions are evaluated.

In addition, special surveys are conducted for a variety of rare or special status species or species of management concern. Examples include surveys for endemic vernal pool plants and invertebrates and various migratory birds.

Study proposals are evaluated by refuge staff to assure that the research is compatible with the Refuge and that some aspect of the results will contribute to wildlife and habitat management. A Special Use Permit (SUP) is issued to each research investigator. The SUP identifies and describes individual projects, provides contact information, identifies where research activities will take place, and describes special conditions to assure the health and safety of the environment and those who visit the Refuges. Because of the number of researchers that may be working on the Refuges at any one time, coordination among the projects and with normal Refuge operations is essential. Researchers have come from universities such as California State University Chico, the University of California (UC) Berkeley, UC Davis, UC Santa Cruz, and the University of Denver. Federal and State agencies such as the U.S. Geological Survey (USGS), USFWS, California Department of Water Resources, and CDFG also conduct research on the Refuges. Researchers investigate a wide range of biological and physical phenomenon. These include topics on wildlife biology (distribution/abundance, reproductive success, predation, and impacts from contaminants), vegetation analysis (growth rates, species composition, succession, and exotic species impacts), water quality, soils analysis, and hydrology.

7.5. Wildlife Disease Monitoring and Treatment

Because the Refuges are a concentration area for migratory birds and other wildlife, there is elevated potential to have significant disease outbreaks and mortality events. Historic disease losses on the Refuges are described in the Waterfowl Disease Contingency Plan (Appendix H).

Avian botulism (Type C) and avian cholera are the two most common wildlife diseases that affect migratory birds at the Refuges. Botulism is generally a warm weather disease that usually occurs between July and October. Botulism spores from the bacteria *Clostridium botulinum* occur naturally in wetlands and can reproduce under the right environmental conditions, including low oxygen levels and warm temperatures (Sandler et al. 1993; Rocke and Samuel 1999). These bacteria produce a powerful neurotoxin that affects the central nervous system of waterfowl and other waterbirds resulting in paralysis and eventually death. During warm months, the disease can

be spread rapidly through a carcass-maggot cycle where maggots that have fed on carcasses concentrate botulism toxin in their bodies and then are consumed readily by other birds, leading to their demise (USGS 1999). Outbreaks during winter or spring months are possible, but much less common and less severe in terms of mortality.

Wildlife disease monitoring
Photo by Jackie Ferrier

Avian cholera is typically a cold weather disease that typically occurs between the months of November and March. With cholera, the bacteria *Pasturella multocida* infects and directly attacks birds' internal organs and respiratory system. Recent studies indicate that cholera does not persist long in the environment (Samuel et al. 2004). Outbreaks are more likely started via carrier birds and transmitted primarily bird-to-bird (Mensik and Samuel 1995; Samuel et al. 1999). While a wide variety of other wildlife diseases have been documented or could potentially occur on the Refuges, botulism and cholera account for the majority of disease management operations.

In the last decade, annual mortality from botulism and cholera in the Sacramento Valley has decreased and may be related to restoration efforts and increases in waterfowl habitat in the Central Valley (Eddings and Eadie 2003).

Other diseases of concern that have not yet been detected or have not been documented to affect many animals at the Refuges include West Nile Virus, Chronic Wasting Disease, and Duck Viral Enteritis.

Since 2005, there have been increasing concerns about highly pathogenic Asian H5N1 avian influenza reaching North America from Asia or Europe, possibly via inter-Flyway movements of migratory birds. Because of the potential of this disease to affect people, surveillance of migratory birds and their habitats for this disease has increased significantly as of 2005 (Interagency Asian H5N1 Early Detection Working Group 2006; Pacific Flyway Council 2006; CDFG et al. 2006). Because of the Refuges' concentration of

waterfowl, a number of Federal and State surveillance efforts continue to be facilitated here.

Avian flu testing
CDFG Photo

Lead poisoning, although technically not a disease, is observed annually on Refuges. Prior to the conversion to non-toxic shot in the late 1980s, lead pellets from spent shotgun shells were deposited annually in wetlands where hunting occurred. Research studies in the late-1980s documented site-specific lead ingestion in mallards on the Sacramento Refuge (Rocke et al. 1997). Conversion to non-toxic shot began on Refuges in 1986. Gizzard collections on the Refuges from 1986 through 1995 documented a decrease in lead ingestion rates, and a corresponding increase in steel or other non-toxic shot ingestion rates (Table 11). While this trend was occurring, other studies identified the continued exposure of waterfowl to lead poisoning on Complex Refuges (Mauser et al. 1990; Rocke et al. 1997). Resulting research documented methods of habitat management designed to address an accumulated lead problem on certain Refuge wetland units (Thomas et al. 2001). In summary, today lead poisoning appears far less frequently in waterfowl using the Refuges' wetland habitats. These results are consistent with other refuges in the Pacific Flyway (Table 12), as well as other parts of the United States (Anderson et al. 2000).

Table 11. Comparison of lead and steel shot ingested by hunter-shot mallards at Sacramento Refuge.

		LEAD			STEEL		
Year	Number with Ingested Shot	Number with Shot (%)	Number with 1 Shot (%)	Number with 2+ Shot (%)	Number with Shot (%)	Number with 1 Shot (%)	Number with 2+ Shot (%)
1975-76[1]	400/46	46 (11.5)	NA[2]	NA	-	-	-
1976-77	454/29	20 (6.4)	22 (4.8)	7 (1.5)	-	-	-
1979-80	110/8	8 (7.3)	NA	NA	-	-	-
1980-81	200/15	15 (7.5)	9 (4.5)	6 (3)	0	-	-
1987-88	101/6	1 (1)	1 (1)	0	5 (5)	5 (5)	0
1988-89	164/3	0	0	0	3 (1.8)	3 (1.8)	0
1989-90	163/7	3 (1.8)	2 (1.2)	1 (0.6)	4 (2.5)	3 (1.8)	1 (0.6)
1990-91	130/2	1 (0.8)	1 (0.8)	0	1 (0.8)	1 (1.8)	0
1991-92	130/6	1 (0.8)	0	1 (0.8)	5 (3.8)	5 (3.8)	0
1992-93	173/9	3 (1.7)	3 (1.7)		6 (3.5)	2 (1.2)	4 (2.3)
1993-94	290/16	6 (2.1)	6 (2.1)	2 (0.7)	11 (3.8)	8 (2.8)	3 (1)
1994-95	137/10	3 (2.2)	3 (2.2)	1 (0.7)	7 (5.1)	4 (2.9)	3 (2.2)

[1] Includes Sacramento, Delevan, and Colusa Refuges and Gray Lodge WMA
[2] Information not available

Table 12. Comparison of lead and steel shot ingested by hunter-shot mallards at Sacramento, Tule Lake, and Ridgefield Refuges.

	1994-95 Mallard Lead/Steel Shot Ingestion Summary							
Refuge	Number of Gizzards Examined	Number with Ingested Shot	Number with Lead	Number with 1 Lead Shot	Number with 2+ Lead Shot	Number with Steel	Number with 1 Steel Shot	Number with 2+ Steel Shot
Sacramento NWR	137	10 7.3%	3 2.2%	2 1.5%	1 0.7%	7 5.1%	4 2.9%	3 2.2%
Tule Lake NWR	104	21 20.20%	9 8.7%	7 6.7%	2 17.3%	18 17.3%	7 6.7%	11 10.6%
Ridgefield NWR	116	41 35.30%	13 11.2%	6 5.2%	7 6.0%	36 31%	20 17.2%	16 13.8%

Wildlife disease monitoring is conducted regularly throughout the year. Wetland units and other areas are inspected regularly and opportunistically for dead or sick animals while conducting other field work. During months of greater outbreak probability, some wetland units with notable disease histories are surveyed via airboat to detect any problems early. During outbreaks, dead birds are located and removed using airboats to systematically cover all areas within a unit. Standard safety precautions are followed when picking up carcasses or conducting other disease surveillance (USGS 1999; USFWS 2006). Monitoring includes documentation by unit for number and condition of dead and sick animals, tracking of effort, and shipment of diagnostic specimens to the USGS National Wildlife Health Center, in Madison, Wisconsin, where the carcasses are necropsied and tested to confirm the cause of death (USGS 1999). Other carcasses may be saved for scientific or educational activities or incinerated. When appropriate, results are shared with other Service divisions (Law Enforcement, National Forensics Laboratory at Ashland, Oregon) and CDFG (game wardens, Wildlife Investigations Laboratory at Rancho Cordova).

8. Visitor Services

8.1. Visitor Services and Management Policy

There are a variety of sources for policy and guidance to manage visitor service programs on Refuges. The Service Manual (605 FW 1-7) provides the policy for wildlife-dependent recreation including hunting, recreational fishing, wildlife observation, wildlife photography, environmental education, and interpretation. The policy also provides guiding principles for each of the wildlife-dependant recreation programs.

Entrance sign at Sacramento Refuge
USFWS photo

In October 1984, the Service published “National Public Use Requirements” to help field stations, including refuges, to plan, implement, and evaluate public use programs. The established requirements are: set public use goals, project a positive attitude,

welcome and orient visitors, develop key resource awareness, provide observation opportunities, maintain quality hunting program, maintain a quality fishing program, and provide public assistance.

In 2007, the Service declared that "connecting people with nature" is among the agencies highest national priorities (USFWS 2008). A connection with nature, whether it's hiking, fishing, camping, hunting, or simply playing outside, helps children develop positive attitudes and behaviors towards the environment. Positive interactions with the environment can lead to a life-long interest in enjoying and preserving nature. People's interest in nature is crucial to the Service mission of conserving, protecting, and enhancing fish, wildlife, plants, and their habitats.

When Service employees were asked to describe a childhood experience where they felt a connection with nature, the answers ranged from memories of riding on the laps of loved ones while mowing the lawn, to family vacations along a lake, beach, or forest, to hiking, climbing trees, and discovering insects, frogs, and birds. Many employees credit these memorable moments for placing them in the career that they are in today. Those experiences were the spark that led to a lifetime of stewardship and conservation. The Service wants to capture that spark and share it with the next generation of conservationists. The Connecting People with Nature Program goals for Region 8 include 1) Rekindle the spark, 2) Share the spark and 3) Ignite the spark. Currently, these goals are being implemented on the Refuges.

A Visitor Services Plan for the Refuges is included in Appendix D.

8.2. Trends

The ability to compare and analyze population and demographic trends is invaluable in making projections about future recreational needs, as well as for assessing existing visitor facilities and programs. The following are highlights of some recreation reports and surveys that are available for consideration when managing the visitor services program.

The Public Opinions and Attitudes on Recreation in California report (California Department of Parks and Recreation 2003) surveyed public attitudes, opinions, and values regarding key areas of interest relating to outdoor recreation opportunities in California; and public participation interests in different types of outdoor recreation activities. The results of this study on the public opinions and attitudes about outdoor recreation in California are in general agreement with past editions of this study. Californians think outdoor recreation areas and facilities are very important to their quality of life (84.1 percent), and more than two-thirds (69.1 percent) reported spending the same or more time in outdoor recreation activities then five years ago. Almost all Californians (96.7 percent) agreed or

strongly agreed that maintaining the natural environment in outdoor recreation areas was important to them. The most important factors influencing enjoyment of recreational activities were being able to relax (75.9 percent), feeling safe and secure (68.3 percent), being in the outdoors (75.9 percent), beauty of the area (61.8 percent), and meeting new people (13.2 percent) ranked last.

Three priority wildlife-dependent activities were surveyed and ranked in this report (Table 13), although it should be noted that the nature study category could also include educational and interpretive activities. Walking for fitness and fun was ranked number one with 91.1 percent participating in an average 94.4 days per year. Driving for pleasure, sightseeing, and driving through natural scenery ranked second with 90.2 percent (31.3 days). Windsurfing showed the lowest percentage participation (3.4 percent), with snowmobiling and orienteering/geo-caching tied for next lowest (4.6 percent). Fifty percent or more of the respondents participated in 11 of the 55 recreation activities at least one day during the 12 months prior to the survey.

Table 13. Ranks of three wildlife dependent activities (California Department of Parks and Recreation 2003).

	Rank	Participation	Average Number of Days Participated
Wildlife viewing, bird watching, viewing natural scenery	8	75.1%	25.3
Fishing (freshwater)	19	34.0%	5.8
Hunting	49	9.0%	1.9

The Park and Recreation Trends in California 2005 report summarizes the State's population and demographic trends affecting parks, recreation areas, programs and services (California State Parks 2005). Some of the highlights include:

- California's population is currently 34 million and will increase ½ million persons annually.
- California is continuing to be more culturally and racially diverse – Asians and Hispanics are the top two groups.
- California's senior population will double by 2010.
- Baby boomers (40-60 years) are reaching retirement age, adding to the citizen-steward group.
- Today's youth (18-40 years) are the most urban of any generation, seeking one-day excursions with multiple activities.

- Understanding how people recreate will be the most effective way to serve visitors.
- California's advanced technology and transportation will expand recreational opportunities.
- Favorite outdoor recreation activities, pertinent to refuges that will continue to dominate include walking, picnicking, sightseeing, and visiting nature centers.
- Day hiking, bicycling, running, and wildlife viewing are predicted to increase in popularity.
- Educational and interpretive programs will continue to be essential to help visitors understand the relationship between humans, nature and cultural heritage.

Recreation trends in the U.S. are found in Outdoor Recreation in American Life: A National Assessment of Demand and Supply Trends (Cordell et al. 1999). Projections were made nationally for four U.S. regions, with California included in the Pacific coast region. Trends for the Pacific region indicate wildlife viewing and nature study are expected to increase by 65 percent and double the number of days per year per person in the next 40 years. Fishing is expected to increase, while hunting is expected to decrease.

American kestrel
Photo by Steve Emmons

The 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation – California (Survey) (USDOI et al. 2006) is a comprehensive publication that provides information about the numbers of U.S. anglers, hunters, and wildlife-watchers by state. The Survey found that 7.4 million California residents and nonresidents 16 years and older fished, hunted, or watched wildlife in California. Of the total participants, 1.7 million fished, 281 thousand hunted, and 6.3 million participated in wildlife-watching activities spending a total of $8.0 billion on wildlife recreation California. When compared to the 1996 Survey (USDOI et al. 1996), the number of anglers decreased by 36 percent, number of hunters decreased by 45 percent, and wildlife-watching (away from home) increased by 23 percent.

Locally, the Sacramento River Public Recreation Access Study (EDAW 2003) was conducted to assess existing and potential public recreation uses, accesses, needs, and opportunities along the Sacramento River between Red Bluff and Colusa. This study indicates a substantial public interest in recreational activities of boating, fishing, and hunting. Additionally, other uses such as bird watching, wildlife viewing, and other nature observation activities, are expected to increase 65 percent over the next 40 years. EDAW (2003) depicts a profile of the potential local refuge visitor as predominately Caucasian, 31-50 years of age with some college education/trade school education. As the population in the region grows, demand for recreation activities will increase. Planning will need to strike a balance between recreation use and conservation goals.

8.3. Visitor Data

The Complex utilizes a variety of methods for estimating the number of annual wildlife-dependent visits. The types of estimation methods used are direct observation, traffic counters, hunter permits, surveys, and estimation based on professional judgment. From these estimates, the numbers of visitors and visits are used to manage and improve the Refuges' visitor services program.

The National Wildlife Refuge System Visitation Estimation Workbook (USFWS 2005c) provides basic principles and definitions that have been used to describe the Refuge visitation estimation program.

Refuge recreational or educational activities that are allowed and monitored include wildlife-dependent recreation (e.g. hunting, wildlife observation, photography, environmental education, and interpretation). Wildlife observation is more specifically reported as auto tour and hiking trail visits.

A Refuge visitor (visitor) is a person that participates in at least one of the wildlife-dependent recreation activities. Visitors do not include staff, volunteers, researchers, contractors, special use permittees, or people who are traveling through the Refuges to reach another non-Refuge location. A single visitor may make several visits to the Refuges during the year by participating in one or more activities.

A visitor is not the same as a Refuge visit (visit). A single visitor can make several visits to a Refuge on a single day by participating in several different activities. The total amount of visits on a given day is a count of only individuals. The amount of time for each individual visit is not accounted for; weather it be minutes to hours.

It should be noted that there is not a 100 percent accurate method of counting all visitors or visits. Therefore, the numbers of visitors or visits reported are only estimates, although, the Refuges strive for

consistency and quality of estimation monitoring methods to improve the accuracy of the information collected. Unfortunately, the reporting systems such as the Refuge Management Information System (RMIS) and the Refuge Annual Performance Plan (RAPP) changed, making it more difficult to accurately compare annual visitation.

Table 14 depicts the number of Refuge visitors and visits for some of the primary wildlife-dependent Refuge activities over the last five years. The environmental education, interpretation and photography blind visits were collected from reservation forms. Hunting visit information was collected from hunting permits and professional estimations of hunting activities (e.g. a hunter in the free roam area may hunt several species during waterfowl and pheasant season). The auto tour and hiking trail visits are a percentage of the vehicle counts that are recorded by a traffic counter at the Refuge entrance. The vehicle counts are multiplied by three based on a Refuge survey that identified an average of three people per vehicle. It should be noted that the 2002-2004 data is based on RMIS reports and 2005-2006 is based on RAPP. The data management systems are not directly comparable, since they each used a different reporting methodology to determine activity visits. The annual visitors are comparable, since the same formula was used. On Sacramento and Colusa Refuges, the formula is: Annual Visitors = Vehicle CountsX3 + Interpretation + EE + Hunting + Photo Blind Visitors. On Delevan and Sutter Refuges, the annual visitors equal the hunting visits.

Western Fence Lizard
Photo by Steve Emmons

Table 14. Refuge Visitation Trends FY 2002-2006

	2002	2003	2004	2005	2006	Five Year Average
Sacramento						
Annual Visitors	**67,619**	**75,528**	**71,617**	**89,138**	**86,165**	**78,103**
Auto Tour Visits	48,345	53,842	51,646	73,149	60,616	**57,520**
Hiking Trail Visits	8,566	8,418	8,064	9,443	8,735	**8,645**
Hunting Visits	8,203	7,052	6,851	7,386	7,683	**7,435**
Environmental Education Visits	2,851	3,027	2,799	3,032	2,528	**2,847**
Interpretation Visits	807	1,065	630	125	150	**555**
Photo Blind Visits	20	33	39	34	33	**32**
Delevan						
Annual Visitors	**6,073**	**5,660**	**5,881**	**5,678**	**6,386**	**5,936**
Hunting Visits	6,073	5,660	5,881	5,678	6,386	**5,936**
Colusa						
Annual Visitors	**24,308**	**31,135**	**26,364**	**20,426**	**16,284**	**25,311**
Auto Tour Visits	16,246	21,847	18,084	16,547	13,027	**17,150**
Hiking Trail Visits	4,185	5,610	4,496	4,127	3,256	**4,335**
Hunting Visits	3,877	3,678	3,784	3,879	3,910	**3,826**
Environmental Education Visits	168	60	65	39	24	**71**
Interpretation Visits	0	0	88	0	0	**18**
Photo Blind Visits	NA	NA	NA	NA	12	**12**
Sutter						
Annual Visitors	**3,058**	**1,241**	**2,620**	**2,870**	**2,152**	**2,388**
Hunting Visits	3,058	1,241	2,620	2,870	2,152	**2,388**
TOTAL ANNUAL VISITORS	**96,924**	**108,135**	**101,869**	**118,112**	**110,999**	**107,208**

8.4. Recreation Fee Program

The Service is one of four Federal land management agencies (Fish and Wildlife Service, Bureau of Land Management, National Park Service, and Forest Service), directed by Congress in 1996 to implement or expand fee collection sites as part of a program to explore the feasibility to better offset costs to administer recreation on public lands.

The fee demonstration program was a four year effort to create innovative approaches and methods to charge and collect fees for recreation services provided on Service lands. An entrance fee program was implemented at Sacramento Refuge during the spring of 1998. This involved constructing a parking area, sidewalk, kiosk with interpretive panels, and automated fee machine.

A survey was completed in 1998 to determine compliance and the number of people per vehicle. The survey revealed that there was a 90 percent compliance of visitors that paid before entering the Refuge.

In 2004, Congress passed the Federal Lands Recreation Enhancement Act which allows the government to charge a fee for recreation use of public lands managed by the Service, Bureau of Reclamation, National Park Service, Bureau of Land Management, and Forest Service.

Currently, there is an entrance fee program for Sacramento Refuge. A fee for vehicles is collected to pay for visitor facilities and wildlife habitat improvements. A $3 day pass, $12 Refuge Annual Pass or $20 commercial pass can be purchased on-site. Holders of a Federal Duck Stamp or Golden Eagle, Age, Access Passport, or America the Beautiful Pass enter for free. The entrance fee is waived for educational groups studying nature as part of a course of curriculum. Visitors pay the entrance fee at an automated fee machine at the entrance to the Refuge.

The entrance fee generates approximately $13,000 annually, which is used to hire two visitor services assistants for October-March. The assistants help with many daily tasks, staff the visitor center on the weekends, facilitate the school groups, update the website, provide hunt data, and answer the phone.

There is also a photography blind fee of $10 per reservation. See the Wildlife Observation section (Section 8.7) for details.

8.5. Hunting

The hunting program is administered by the Service in cooperation with the CDFG. The Service manages the Refuges' land, habitat and facilities; the CDFG selects and processes the Refuge hunters.

Hunting is permitted on portions of Sacramento, Delevan, Colusa, and Sutter Refuges. Hunting of waterfowl, coots, common moorhens, snipe, and pheasants is permitted on Saturdays, Sundays, and Wednesdays during hunting seasons established by the California Fish and Game Commission.

Waterfowl hunter
Photo by Mike Carpenter

The Refuges have spaced blinds, spaced hunt sites (islands), assigned ponds, and free roam areas. Pheasants may only be hunted in the free roam areas, except for the Special Monday Pheasant Hunt, which is held the first Monday of the regular season. On this day, the entire hunt areas at Sacramento, Delevan, and Colusa Refuges are opened to pheasant hunting, including the spaced blind and assigned pond areas.

Harvest success, as measured by the number of birds per hunter per day (average), has remained comparatively consistent since the Refuge hunting programs were established. This consistency has occurred despite some rather significant changes in regulations, total birds harvested on the Complex, and trends on individual Refuges. For the four Refuges, the average number of birds per hunter in recent years is approximately 2.25 to 2.50, plus or minus 0.5 depending on the Refuge or year. All individual Refuge averages are typically equal to or greater than the annual average for all "Type A" public hunt areas in California. For example, for the 2006/07 waterfowl season, Colusa (2.97), Delevan (3.3), Sacramento (2.65) and Sutter (2.46) Refuges all exceeded the statewide season average of 2.37 birds per hunter. Hunter success does vary by day, with weather conditions being the primary reason for the differences. However, all other factors being equal, the second consecutive day (Sunday) of hunting usually results in a lower average than the preceding hunt day (Saturday) or the middle of the week (Wednesday).

Harvest data indicate that ducks make up 95 percent of the hunter bag. The top six species of ducks harvested are mallard (22.3 percent), gadwall (18.5 percent), green-winged teal (14.5 percent), northern shoveler (13.5 percent), American wigeon (12.6 percent), and northern pintail (7.5 percent) (Table 15). Geese harvested include snow (53.8 percent), white-fronted (30.2 percent), and Ross's (13.4 percent) (Table 16). The majority of the goose harvest occurs on Sacramento and Delevan Refuges.

Table 15. Primary Duck Species Harvested on the Sacramento Complex (2004-2006 Season).

	Mallard	Gadwall	GWTeal	Shoveler	Wigeon	Pintail
Sacramento						
2006-07	2,992	3,324	2,029	3,294	2,015	1,688
2005-06	3,053	2,184	2,094	2,340	1,770	1,519
2004-05	3,392	2,237	1,995	1,794	1,373	1,112
Average	**3,146**	**2,582**	**2,039**	**2,476**	**1,719**	**1,440**
Delevan						
2006-07	2,991	4,332	2,518	3,959	2,304	1,553
2005-06	4,037	3,001	2,504	2,200	2,257	1,412
2004-05	3,319	2,854	2,117	1,776	1,808	655
Average	**3,449**	**3,396**	**2,380**	**2,645**	**2,123**	**1,207**
Colusa						
2006-07	1,287	2,774	1,770	1,468	868	720
2005-06	2,912	1,736	1,538	716	814	678
2004-05	2,625	2,067	1,639	734	1,248	381
Average	**2,275**	**2,192**	**1,649**	**973**	**977**	**593**
Sutter						
2006-07	2,182	564	1,138	792	1,481	665
2005-06	1,558	227	587	176	613	263
2004-05	1,875	1,469	1,026	299	1,469	249
Average	**1,872**	**753**	**917**	**422**	**1,188**	**392**
Average Total	**10,742**	**8,923**	**6,985**	**6,516**	**6,077**	**3,632**
Percent of Grand Total[1]	**22.3**	**18.5**	**14.5**	**13.5**	**12.6**	**7.5**

[1] The Grand Total includes other duck species that were harvested (48,233 = Grand Total).

Waterfowl hunting
USFWS photo

Table 16. Primary Goose Species Harvested on the Sacramento Complex (2004-2006 Season).

	Snow	Ross's	White-front
Sacramento			
2006-07	1,614	295	652
2005-06	985	220	317
2004-05	835	196	285
Average	**1,145**	**237**	**418**
Delevan			
2006-07	1,344	229	736
2005-06	1,061	204	364
2004-05	461	176	354
Average	**955**	**203**	**485**
Colusa			
2006-07	435	221	88
2005-06	227	84	45
2004-05	149	90	84
Average	**270**	**132**	**72**
Sutter			
2006-07	204	90	834
2005-06	73	14	203
2004-05	44	37	208
Average	**107**	**47**	**415**
Average Total	**2,477**	**619**	**1,390**
Percent of Grand Total[1]	**53.8**	**13.4**	**30.2**

[1] The Grand Total includes other goose species that were harvested (4,599 = Grand Total).

Snow goose
Photo by Steve Emmons

8.5.1. Sacramento Refuge Hunting History

In 1963, the Sacramento Refuge was opened to public hunting of waterfowl. The program was initiated by the Service in conjunction with CDFG, whose staff members presently operate the program. Approximately 3,585 acres of the southern portion of the Refuge was opened to a maximum of 250 adult hunters. The initial fee was $2.50 per hunter per day. Hunters were largely dependent on a first come, first served system and a mail-in reservation system for obtaining a permit to hunt. The number of hunters on any given day remains about twice the actual capacity of the hunting area. Hunters leaving the area are usually quickly replaced by others waiting to hunt.

Sacramento Refuge check station (1964)
USFWS Photo

In 1978, the spaced blind program was initiated in order to improve the quality of the hunt and to meet national and regional policies. This involved the elimination of firing lines, overcrowding, and extreme competition among hunters. The blinds were either in-ground metal pits or above-ground platforms that could accommodate up to four hunters. The blinds were well spaced to improve safety and hunting quality. In the early years, hunters were assigned a blind, but more recently have been allowed to select their blinds in order of their reservation or sweat line numbers. They were required to hunt from within their assigned blinds until 1991, when the regulation was relaxed to include the area within 100 feet of the blind. During 1997 to 2003, concrete pit blinds were installed to replace all the metal pit and platform blinds. Safari Club International contributed the first two blinds, Blinds 9 and 13.

In 1991, the Refuge eliminated the requirement that non-reservation hunters remain in the check station parking lot after receiving their sweat line number. In addition, an on-site lottery draw system for non-reservation numbers was implemented to reduce overnight camping and provide a more equitable system of hunter access. A new check station building was constructed in 1999, and an

information kiosk was installed near the check station in 2004. The first assigned pond, replacing Blind 55, was established in 2006.

A Special Monday Pheasant Hunt was added to the hunt program in 1981. In addition, in 1991 an annual one-day Junior Waterfowl Hunt in the spaced blind area began. The first Youth Waterfowl Hunt was hosted on the Saturday before the opening of waterfowl hunting season in October 1996. Thereafter, Youth Hunts were hosted during the weekend after the end of the waterfowl hunting season.

In 1997, as the result of an accessibility evaluation, two additional disabled blinds, Blinds 23D and 27D, were constructed.

8.5.2. Sacramento Current Hunting Conditions

Hunting of waterfowl, coot, common moorhen, snipe, and pheasant is restricted to 3,566 acres south of Road 68 on Sacramento Refuge on Wednesdays, Saturdays, and Sundays during the legal seasons (Table 17).

Table 17. Sacramento Refuge Hunting Conditions.

	Spaced Blind Area	Assigned Pond Area (# parties)	Free Roam Area	Pheasant Only
Acres dry	241	27	336	127
Acres flooded	1606	55	1,174	
Total acres	1847	82	1,510	
Number of blinds	45			
Number of assigned ponds		1		
Maximum adult hunter quota	180	4 (1)	75	
Wetland acres/hunter or hunt site	35.7	55	15.6	

Sacramento Refuge has spaced blind, assigned pond, and free roam areas that consists of managed wetland, grassland, vernal pool, and alkali meadow habitats. Blinds are in-ground, concrete pits spaced 250 to 400 yards apart. Hunters must remain within 100 feet of their assigned blind. Free roam and assigned pond hunters move unrestricted within the signed hunting area boundary. Directional signs guide hunters to their respective hunting areas, while additional reflective stakes direct hunters to their specific blind site. The hunting areas are accessible only by foot from four parking areas.

Pheasant and snipe may be hunted on waterfowl hunt days in the free roam and pheasant only areas. Pheasant may also be hunted on the

first Monday of the season in free roam, spaced blind, and assigned pond areas.

Hunter quotas are based on acres of available wetland habitat and are adjusted depending upon water conditions. Fully flooded conditions provide up to 45 blinds (up to four people per blind), one assigned pond (up to four people) and up to 75 hunters in the free roam area. In addition to quotas, habitat management, pond size, daily weather conditions, and waterfowl flight patterns influence hunter distribution.

Sacramento Refuge has three blind sites (Blinds 5D, 23D, and 27D) designated for hunters with disabilities. These sites may be accessed by motor vehicle or an all-terrain-vehicle from the parking areas. Additionally, there is a parking area to access Blinds 23D and 27D, and a designated boat launch in the free roam area of Tract 38 for hunters with disabilities. During the 2006/2007 season, there were 212 visits by 62 individual hunters with disabilities.

Waterfowl hunting from disabled hunting blind
USFWS photo

8.5.3. Delevan Refuge Hunting History

The hunt program at Delevan Refuge began in 1963 with the opening of 2,000 acres to free roam hunting. In 1989, a portion of the free roam area was converted to accommodate 26 spaced hunting sites or islands. These sites could accommodate up to four hunters and were well spaced to improve safety and hunting quality. Hunters selecting such sites were required to remain within 100 feet of a marker stake designating the assigned hunting site and were limited to waterfowl hunting only. Pheasant and snipe were harvested in the free roam areas only. The Delevan check station was moved from off of Maxwell Road to Tract 27 off of Four Mile Road in the 1980s. A new check station was constructed in 1997 and a hunter kiosk was installed in 2003. In 2004, assigned ponds were established on Delevan Refuge. Ponds 11 and 12A were the first to become assigned ponds, followed by Pond 17 in 2005.

In 1994, a blind was constructed in Tract 27.2 in a small pond close to the check station and was opened to disabled hunters only. In 1997, Blind 13D was added as an additional disabled site and the original disabled blind was renamed as Blind 29D. Able-bodied hunters were allowed to refill both blinds after 3:00 p.m.

In 1998, the Disabled Access Working Group (DAWG) requested the Service construct Blind 30D. The Refuge was concerned that if both Blinds 30D and 29D were filled with four hunters, a firing line might result. In 2001, the CDFG check station manager reported that Blind 30D was cutting off the natural flyway from the north closed area into the free roam area south of Blind 30D. Since that time, the Complex, Refuge Hunting Program Working Group, and DAWG have studied various proposals to locate an alternate site for Blind 30D. A flyer was distributed at the check stations, but no suggestions were received. The Service is now considering leaving Blind 30D at the present location. Since Blinds 29D and 30D are located in small ponds, there is no refill by able-bodied hunters after 3:00 pm.

In 2004, the Refuge introduced a floating pontoon blind in the free roam area for mobility-impaired hunters. The pontoon boat was purchased with a grant from Safari Club International.

The first Special Monday Pheasant Hunt was started in 1989. In 1991, the Refuge eliminated the sweat line system altogether and implemented an on-site lottery draw system for non-reservation hunters. In 1992, an annual one-day Junior Waterfowl Hunt in the spaced blind area began. The first Youth Waterfowl Hunt was hosted on the Saturday before the opening of waterfowl hunting season in October 1996. Thereafter, Youth Hunts were hosted during the weekend after the end of the waterfowl hunting season.

Junior waterfowl hunter
USFWS photo

8.5.4. Delevan Current Hunting Conditions

Hunting of waterfowl, coot, common moorhen, snipe, and pheasant is restricted to 1,922 acres on the south half of Delevan Refuge on Wednesdays, Saturdays, and Sundays during the legal seasons (Table 18).

Table 18. Delevan Refuge Hunting Conditions.

	Spaced Hunt Area	Assigned Pond Area (# parties)	Free Roam Area
Acres dry	22	0	192
Acres flooded	746	129	*833
Total acres	768	129	1,025
Total blinds	26		
Total Assigned Ponds		3	
Maximum adult hunter quota	104	12 (3)	**58
Wetland acres/hunter or hunt site	28.7	43.0	14.4
* Does not include acres for T41.2 when it gets flooded December - January **Increased to 62 during December-January when T41.2 is flooded			

Delevan Refuge has spaced hunt sites, assigned ponds, and a free roam area that consists of managed wetland, grassland, vernal pool, and alkali meadow habitats. Hunt sites consist of a dirt island (approximately 10 feet x 20 feet) surrounded by cattail or bulrush. Hunters must remain within 100 feet of their assigned hunt site. Free roam and assigned pond hunters move unrestricted within the signed hunting area boundary. Directional signs guide hunters to their respective hunting areas, while additional reflective stakes direct hunters to their assigned hunt site. The hunting areas are accessible only by foot from three parking areas.

Pheasant and snipe may be hunted on waterfowl hunt days in the free roam areas. Pheasant may also be hunted on the first Monday of the season in free roam, spaced hunt sites, and assigned pond areas.

Hunter quotas are based on acres of available wetland habitat and are adjusted depending upon water conditions. Fully flooded conditions provide up to 26 hunt sites (up to four people per hunt site), three assigned ponds (up to four people per pond) and up to 58 free roam hunters. In addition to quotas, habitat management, pond size, daily weather conditions, and waterfowl flight patterns influence hunter distribution.

Delevan Refuge has three spaced hunt sites (Blinds 13D, 29D, and 30D) designated for hunters with disabilities. These sites may be

accessed by motor vehicle or an all-terrain-vehicle from the parking areas. A floating pontoon blind is located in Tract 34.3 as a free roam hunting opportunity. In addition, there are designated disabled accessible boat launches in the free roam area of Tracts 33 and 34.3. In the 2006/2007 season, there were 223 visits by 53 individual hunters with disabilities.

8.5.5. Colusa Refuge Hunting History

Colusa Refuge was opened to free roam hunting in 1950. The hunting area acres have ranged from 1,100 in the 1960s to 1,921 acres today. The lottery draw was implemented in 1998. Also in 1998, a boat ramp and disabled parking area were constructed. A new hunter check station was constructed in a more southern location (Tract 23) in 1999, and an information kiosk was installed in 2004. In 2004, eight assigned ponds were established and, in 2005, the first blind for disabled hunters was constructed in the northeast corner of Pool 2.

Colusa Refuge check station (1953)
USFWS Photo

8.5.6. Colusa Current Hunting Conditions

Hunting of waterfowl, coot, common moorhen, snipe, and pheasant is restricted to 1,921 acres south of Able Road on Colusa Refuge on Wednesdays, Saturdays, and Sundays during the legal seasons (Table 19).

Table 19. Colusa Refuge Hunting Conditions.

	Assigned Pond Area (# parties)	Free Roam Area West	Free Roam Area East	Pheasant Only Area
Acres dry	0	488	67	60
Acres flooded	339	429	538	
Total acres	339	917	605	
Total assigned ponds	8			
Maximum adult hunter quota	26 (13)	14	40	
Wetland acres/hunter or hunt site	26.1	30.6	13.4	

Colusa Refuge has assigned pond and free roam areas that primarily consists of managed wetland, grassland, vernal pool, and alkali meadow habitats. Free roam and assigned pond hunters move unrestricted within the signed hunting area boundary. Directional signs guide hunters to their respective hunting areas. The hunting areas are accessible only by foot from three parking areas. In addition, hunters with disabilities may access Pool 2 from the disabled parking area via a boat ramp or access a blind in the northeast corner.

Pheasant and snipe may be hunted on waterfowl hunt days in the free roam and pheasant only areas. Pheasant may also be hunted on the first Monday of the season in free roam and assigned pond areas.

Greater white-fronted geese
Photo by Steve Emmons

Hunter quotas are based on acres of available wetland habitat and are adjusted depending upon water conditions. Fully flooded conditions provide up to eight assigned ponds (two adult hunters per party) and up to 54 free roam hunters. Ponds 4, 5 and 7-10 allow one party per pond, Pool 1 allows up to four parties per pond. Pool 2 allows up to three parties including two disabled parties and one party which must have a junior hunter. In the 2006/2007 season, Pool 2 had 236 hunter visits and the hunters that reported using the blind on 10 days resulted in 22 hunter visits. In addition to quotas, habitat management, pond size, daily weather conditions, and waterfowl flight patterns influence hunter distribution.

8.5.7. Sutter Refuge Hunting History

The hunt program began on Sutter Refuge in 1953 when 1,350 acres were opened to free roam hunting. Since that time, the annual hunt program has varied from a complete closure in 1978, to a maximum of 1,441 acres in 1987. The Refuge is located in the Sutter Bypass and consequently has suffered from flooding and resultant temporary closures of the hunt program more frequently than any other Refuge on the Complex. A boat access ramp in Tract 17 for disabled hunters was constructed in 1998.

Sutter Refuge check station (1956)
USFWS Photo

8.5.8. Sutter Current Hunting Conditions

Hunting of waterfowl, coot, common moorhen, snipe, and pheasant is restricted to 1,116 acres on the south half of Sutter Refuge on Wednesdays, Saturdays, and Sundays during the legal seasons (Table 20).

Table 20. Sutter Refuge Hunting Conditions.

	Free Roam Area	Pheasant Only Area
Acres dry	0	125
Acres flooded	987	4
Total acres	987	129
Maximum hunter quota	70	
Wetland acres/hunter	14.1	

Sutter Refuge is entirely a free roam area that primarily consists of managed wetland and grassland habitats. Hunters move unrestricted within the signed hunting area boundary. The hunting areas are accessible only by foot from two parking areas. In addition, there is a designated boat launch with a parking area available to hunters with disabilities, in the southeast corner of Tract 17. There are minimal

disabled hunter visits on Sutter Refuge. Pheasant and snipe can be hunted in the free roam and pheasant only areas on the Refuge on waterfowl hunt days.

Hunter quotas are based on acres of available wetland habitat and are adjusted depending upon water conditions. Fully flooded conditions provide up to 70 free roam hunters. In addition to quotas, habitat management, pond size, daily weather conditions, and waterfowl flight patterns influence hunter distribution.

8.5.9. Hunter Working Groups

The Refuge Hunting Program Working Group was established in 1991 to exchange ideas and information regarding the Complex hunting program. The Disabled Access Working Group was established in 1999 to discuss disabled hunting access issues on the Complex. In 2006, the groups were combined to form the Sacramento Refuge Complex Hunting Program Working Group.

8.6. Fishing

Currently there is no public fishing access on Sacramento, Delevan, Colusa, and Sutter Refuges.

Fishing once occurred on all four of the Refuges. The angler visits were estimated by periodic surveys. The most common fish caught were channel catfish, yellow bullhead, bluegill, perch, sunfish, carp, and largemouth bass.

Sacramento Refuge fishing access was open 1964 to 1991 during February 15 to October 1 along Logan Creek for one mile south of Road 68. Visitation was estimated through periodic surveys at just over 500 visits annually. Anglers were reported to catch primarily catfish and largemouth bass. The most popular place to fish was not on Refuge property. Visitors would park on County Road 68 and fish near the bridge. There was reoccurring problems with litter and trespass north into the closed area, which disturbed wildlife including nesting birds. Subsequently, the area was closed to fishing in 1991.

Almost two miles of fishing access was open along the Delevan Refuge's Colusa Basin Drain. The area was open 1964 to 1993 during February 15 –October 1. Angler visits over a 1990 to 1993 varied from approximately 940 to 2,880 annually, with catfish and largemouth bass the primary fish caught. Unfortunately, vandalism of Refuge gates and signs, trespass on Refuge land and adjacent private properties, illegal campfires, and destruction of Federal property occurred repeatedly. Following written and verbal complaints from the Maxwell Irrigation District, law enforcement was increased to educate anglers about Refuge regulations. In spite of these increased efforts, vandalism continued throughout the year. Because water quality was questionable, relatively few regular anglers utilized the area and the fishing area was closed in 1994.

Colusa Refuge was open to fishing from 1963 to 1989 along a 1¼ mile stretch of the Colusa Basin Drain. Since the fishing area was not located on Refuge property, the fishing signs were removed in 1989.

Anglers fished in the Sutter Bypass, but the official date of opening Sutter Refuge to fishing to the public was never documented. In 1962, it was noted that anglers along the boundaries of the Refuge were a nuisance, stating that they would burn or destroy signs, litter, and trespass. In 1963, it was recorded that anglers were attracted to the area, reaching up to 50 vehicles per day and they also caught up to 8 pound catfish. As on the other Refuges, due to the repeated violations, refuge management closed the area to fishing.

8.7. Wildlife Observation

Numerous wildlife observation opportunities are available on the Refuges. On Sacramento Refuge, the six-mile auto tour route and two-mile walking trail (Wetlands Walk Trail) meander along marshes and riparian areas. There are two park and stretch areas on the auto tour route where visitors are encouraged to get out of their vehicles to view wildlife. At the first park-and-stretch area halfway along the auto tour route, there is a three-tier wildlife viewing platform with two spotting scopes. The auto tour route and trail are open sunrise to sunset year-round.

Wildlife viewing platform at Sacramento Refuge
USFWS photo

On Colusa Refuge, visitors enjoy wildlife viewing and photography as they drive the three-mile, graveled auto tour route adjacent to managed wetlands. A universally accessible wildlife viewing platform is located at the beginning of the auto tour route. A one-mile walking trail (Discovery Walk Trail) is located along a lush riparian slough. The auto tour route and trail are open sunrise to sunset year-round.

Wildlife viewing platform at Colusa Refuge
Photo by Mike Peters

Wildlife observation on Delevan and Sutter Refuges is limited to adjacent county roads. Delevan Refuge also has an undeveloped Watchable Wildlife site on Maxwell Road, adjacent to the Refuge's southern boundary.

8.8. Wildlife Photography

The auto tour routes and walking trails on Sacramento Refuge and Colusa Refuge provide excellent photographic opportunities. The best time of year for photography occurs from November through February, when a variety of waterfowl and shorebirds are present.

View from Photo Blind 1
Photo by Mike Peters

Additionally, there are two photography blinds on Sacramento Refuge and one on Colusa Refuge. The blinds may be reserved one day each week only on Wednesdays through Sundays for a small fee ($10). They are also available October through March depending on habitat conditions. Photographers may request up to three reservations each season and may be placed on a waiting list if the blind or day requested is filled. Photographers also complete an

evaluation that reports photographed species, time spent, and comments.

Photographers must be in the blind at least one-half hour before sunrise. They must park in the designated parking area and proceed directly to the assigned blind on foot. Stakes with reflective tape mark the route from the parking area to the blind. The route is designed to minimize disturbance; therefore, deviation from the staked route is not allowed. Photographers may leave the blind at any time, but once the blind has been vacated, returning to the blind is not permitted.

Photo Blind 2 at Sacramento Refuge
Photo by Steve Emmons

The blinds are approximately 300 yards within the wetlands. They are 42' x 6' wide and 5' high. They have adjustable camera size openings in three sides. The blinds accommodate one person comfortably; however, two people at a time are allowed. Tree snags and islands have been placed to encourage birds to perch or rest about 40 feet from each blind.

8.9. Environmental Education

Environmental education is comprised of teacher or leader-conducted activities that are intended to actively involve students or others in hands-on activities. These activities are designed to promote discovery and fact-finding, develop problem-solving skills, and lead to personal involvement and action. The Service focuses on kindergarten through twelfth grade students.

The Environmental Education Guide for the Complex describes the activities, facilities, and resources available on the Refuges. The environmental education program was restructured in 2005 to increase the involvement of teachers or leaders in conducting their pre-selected activities. The program offers several ways for the classes to experience the Complex. Specifically, at the Sacramento Refuge they are welcomed by visitor services staff and have access to the diorama, Discovery Room, and Refuge videos. For the remainder of their visit, the teachers or leaders guide their group through their pre-planned tour using the two-mile walking trail, kiosk area and six-

mile auto tour. On Colusa Refuge, students utilize the new visitor facilities including restrooms, welcome kiosk, viewing platform.

Although the Refuges are open to the public from sunrise to sunset daily, we encourage groups to make reservations two weeks in advance to ensure that they will have the best possible experience and that needed resource materials are available. They may call, fax or visit our website to make reservations.

8.9.1. Wetlands Walk

On Sacramento Refuge, visitors using the Wetlands Walk Guide may meander through the fourteen stops on the two-mile trail for an hour long adventure or if time is limited, walk only halfway after experiencing an abundance of unique viewing opportunities.

8.9.2. Discovery Packs and Teacher Resources

For an even more comprehensive environmental education experience, there is a fully equipped backpack, or Discovery Pack, to teach as many as five activities along the Wetlands Walk. The pack contains dip nets, field guides, plant mounts, bug boxes, lenses, and written materials. A teacher's guide can be sent, upon request, prior to the visit.

Binoculars and waterfowl guides are also available on loan from the Refuge Headquarters. The Environmental Education Guide and the Complex website list many other resources available.

8.9.3. Auto Tour with Radio Station

Visitors may tune into Sacramento Refuge's radio station (93.1 FM) to learn about the diversity of plants and animals as they drive the auto tour.

Sacramento Refuge auto tour route
Photo by Steve Emmons

8.9.4. Junior Duck Stamp Program

Sacramento Refuge coordinates the Federal Junior Duck Stamp Conservation and Design Program for California. As the State coordinator, refuge staff manages the art contest, outreach, and art tour of the winning youth art entries. Students in kindergarten through high school are involved in this innovative, curriculum-based program through an annual art competition in each state. Further information about the Federal Duck Stamp Program and Federal Junior Duck Stamp Art Contest may be found on the website: www.fws.gov/duckstamps.

8.10. Interpretation and Outreach

Interpretation involves participants of all ages who learn about the complex issues confronting fish and wildlife resource management as they voluntarily engage in stimulating and enjoyable activities. First-hand experience with the environment is emphasized although presentations, audiovisual media, and exhibits are often necessary components of the interpretive program. The Service's Children and Nature initiative (USFWS 2008) strives to ensure that America's children have enjoyable and meaningful experiences in the out-of-doors and develop strong life-long connections with the natural world. The Refuges also strive to meet this initiative.

Refuge brochures providing information on the Complex, Watchable Wildlife, and hunting have been developed and revised over the years. The Wetlands Walk Guide and the Sacramento Valley Birding Trail Guide and Map were completed in 2006. A variety of videos are also available for viewing upon request. The Sacramento Valley Refuge: An Unfinished Symphony and America's National Wildlife Refuge System: Where Wildlife Comes First, are the most popular videos. The Unfinished Symphony was written and filmed on location in 2003 as part of the Refuge System Centennial Celebration.

A bookstore in the Sacramento Refuge Visitor Center (Headquarters Office) was created in 1990 via cooperative agreement with the San Francisco Bay Wildlife Society. The cooperative agreement was terminated with San Francisco Bay Wildlife Society in 2001 and a new cooperative agreement was signed with Altacal Audubon Society of Chico, CA in 2002.

Refuge-related information is provided at annual local festivals or during special events, such as the California State Fair, International Migratory Bird Day, Snow Goose Festival, National Wildlife Refuge Week, Pacific Flyway Decoy Association, Coleman National Fish Hatchery Salmon Festival, Chico Endangered Species Fair, California Waterfowl Association (CWA) Art Camp, and CWA Marsh Madness. During 2005, approximately 13,000 individuals attended the presentations and saw exhibits at these events.

8.10.1. Website

Refuge staff maintains a website for the Complex: http://sacramentovalleyrefuges.fws.gov. Events, wildlife survey data, hunting data, planning documents, and information about the Refuges are posted on this website.

8.11. Non-wildlife dependent Recreation

The only non-wildlife dependent recreation permitted on the Refuges is bicycling on the auto tour route on Sacramento Refuge. Bicycling can facilitate non-consumptive priority public uses, including wildlife observation, photography, environmental education, and interpretation.

8.12. Youth Program

A Youth Conservation Corps (YCC) program, the first in over two decades, was implemented during the summer of 2005. It consisted of one crew leader and four crew members and, in 2006, expanded to include one youth leader. During the eight-week program, enrollees complete maintenance, fence construction, and painting projects. YCC contributes over 1,000 work project hours annually. For every eight hours of work, one hour of environmental education is provided as field trips, presentations, or discussions.

YCC crew installing burrowing owl nesting box
USFWS photo

8.13. Volunteer Program

The National Wildlife Refuge System Volunteer and Partnership Enhancement Act of 1998 (P.L. 105-242) strengthens the Refuge System's role in developing relationships with volunteers. Volunteers possess knowledge, skills, and abilities that can enhance the scope of Refuge operations. Volunteers enrich refuge staff with their gift of time, skills, and energy. Refuge staff will initiate, support, and nurture relationships with volunteers so that they may continue to be an integral part of Refuge programs and management. The volunteer program is managed in accordance with the Fish and Wildlife Service Manual, Part 150, Chapters 1-3, "Volunteer Services Program", and Part 240 Chapter 9 "Occupational Safety and Health, Volunteer and Youth Program".

Currently the volunteer program consists of 69 individuals that assist with biological, environmental education, interpretation, wildlife observation, hunting, and maintenance events and activities. Additional individuals are signed up for one-time events such as Brush Up Day of the hunting areas and trail maintenance by Altacal Audubon Society. The Refuges also support and participate in annual Eagle Scout projects.

9. Cooperation with Adjacent Landowners

The Refuges are part of a mosaic of public and private land in the Sacramento Valley. Private lands are mostly agricultural land (rice, orchards, row crops), with some private duck-hunting clubs, farmsteads, businesses, trailer parks, and isolated homes. To maximize our conservation efforts the Complex encourages and supports the cooperative approach to problem solving by working with neighbors on common issues (e.g. trespass, fire and fuel break management, drainage, etc.). The refuge manager is the primary contact for the cooperation with adjacent landowners.

10. Fire Prevention and Hazard Reduction

Fire prevention and fire hazard reduction programs are intended to protect and reduce risks to human life and property at nearby homes, farms, businesses, developed areas, structures, improvements, and the Refuge boundaries. The Wildland Urban Interface (WUI) program is part of the National Fire Plan and is designed to reduce the potential for wildfire damage in zones where wildlands and infrastructure (assets at-risk) mix. The WUI program emphasizes pre-fire management around communities that are listed as "at-risk" to wildfire in the Federal Register and by the state of California.

The program is part of a national stimulus package to implement wildfire hazard reduction projects on Federal lands, especially emphasizing use of local contractors. Development of site-specific projects includes collaboration with local landowners, local, county and State firefighting departments, the refuge manager, biologists, and fire management officer. Projects include, but are not limited to

prescribed burns for fuel reduction, permanent fuel breaks, selective cutting, grazing, mowing, or disking along boundaries and developed areas, and cooperative agreements with local fire districts for wildfire suppression.

The Refuges have a fire management program of ten employees (six permanent and four seasonals) and three engines. A regional Wildland Urban Interface Specialist is also stationed at Sacramento Refuge and assists with development and implementation of fire protection programs throughout the Complex.

The Complex has averaged nine prescribed fires per year over the last ten years, averaging about 560 acres burned per year. Objectives for all of these burns include hazard reduction. Additional objectives have also included threatened and endangered species management, invasive plant reduction, habitat maintenance, and disease prevention.

The Complex has averaged four wildfires per year over the last ten years, burning an average of about 113 acres per year. Many of these fires have started off-Refuge. Refuge fire crews have also responded to wildfires adjacent to Refuge property under local, county, and statewide wildfire mutual aid agreements. All wildfires have been human-caused, including escaped fires from the burning of fields, ditches, or natural vegetation (17 fires of 50 recorded in 15 years). Other causes have included trains, mowers and agricultural equipment, electrical lines/equipment, smoking, and intentional/suspicious.

11. Law Enforcement and Resource Protection

The staff of the Complex recognizes the obligation that has been entrusted to them--the care of valuable natural and cultural resources--and they take this responsibility very seriously.

Law enforcement on the Refuges is used both for protection and for prevention. Used for protection, law enforcement safeguards the visiting public, staff, facilities, and natural and cultural resources from criminal action, accidents, vandalism, and negligence. Used as prevention, law enforcement inhibits incidents from occurring by providing a law enforcement presence.

The Complex has a law enforcement staff that consists of two full-time refuge officers and one dual-function officer. These officers are responsible for all law enforcement issues on Sacramento River, Sacramento, Delevan, Colusa, and Sutter Refuges, and on Butte Sink and North Central Valley Wildlife Management Areas. Dual-function officers conduct law enforcement as a “collateral duty” in addition to their primary responsibility, such as an assistant refuge manager. The regional Northern California Zone Officer is also stationed at

Sacramento Refuge and assists with law enforcement issues on the Complex.

The refuge officers are responsible for coordinating their activities and cooperating with other local, State, and Federal law enforcement officials.

12. Facilities Maintenance

The Refuge shops, offices, and visitor parking areas require frequent maintenance and repair. Currently, the Refuges have eleven wage grade positions that are responsible for maintenance and operations. General road maintenance, including grading and mowing, is required on a number of the Refuge units to provide safe access through the Refuges. Some additional upland areas require mowing to reduce fire hazards, provide weed suppression, and provide access for maintenance or monitoring projects during the spring and summer months.

Construction of building pad at Sacramento Refuge
Photo by Steve Emmons

In order to maintain the integrity of Refuges, it is critical to reduce trespass, dumping, and poaching on Refuge lands. It is the intent of the Service to maintain a positive working relationship with neighbors to reduce trespass, vandalism, and theft on adjacent landowner properties. To achieve these goals, the Refuges have fenced, signed, and gated the Refuges boundaries. This infrastructure helps to alleviate trespass problems. Annually, most Refuge units will require installation of some new posts due to vandalism. Information signs are maintained on each of the Refuges.

13. Safety

Safety is important both for the Complex staff and for Refuge visitors. Staff safety meetings are held monthly at the Refuge Headquarters. The intent of the meetings is to update and train personnel, as well as to resolve any safety concerns that arise. Sample topics include Lyme's Disease, West Nile Virus, and Hantavirus Safety, Tractor Safety, Hazardous Dump Sites, Boating

Safety, CPR/First Aid, Hypothermia, Low visibility Driving, Heat Stress, and Respiratory Safety.

The Complex has a Safety Plan, updated annually, that describes the safety program and the responsibilities of the refuge staff and volunteers. The Safety Plan has an extensive amount of safety information provided in the Appendices. A safety committee comprised of a collateral duty safety officer and five additional people meets regularly throughout the year to discuss safety issues and coordinate safety inspections.

14. Cultural Resources

From the late Pleistocene, more than 10,000 years ago, to present time, humans have occupied northern California and utilized its generous natural resources. Many diverse and complex cultures developed during this time, culminating in the Native American Tribes recorded by early ethnographers.

Wintun (Nomlaki) occupied both banks of the Sacramento River and the valley and foothills west of the River. The northwest Maidu lived in the valley, east of the River, along Butte and Big Chico Creeks, and had territories extending into the eastern foothills and mountains. The southern-most Yana tribe (Yahi) occupied lands east of the River, north of the Big Chico Creek. The territories of these tribes overlapped seasonally. For example, during the summer months the Nomlaki moved from the alluvial plain of the Sacramento River onto the alluvial fan of adjacent eastern foothills, while Yahi and northwest Maidu moved east, into the southern Cascade and northern Sierra Nevada Mountains, respectively. These people fished for Chinook salmon and hunted for tule elk, pronghorn, black-tailed deer, rabbits, California quail, and waterfowl. They also harvested acorns and a variety of seeds, roots, tubers, and bulbs from native plants (Goldschmidt 1978; Johnson 1978; Riddlell 1978).

Under natural conditions, the Colusa Basin, in which the Refuges are situated, was characterized by vernal pools, which supported large numbers of waterfowl in the winter. Topographic features of the area generally were not favorable for extended occupation by the indigenous tribes, although temporary camps may have resulted from hunting and gathering activities.

Euro-American contact with native tribes in the region began with the Spanish Moraga expedition of 1808. In the 1820s, fur trappers, such as Jedediah Smith, were working in the area. By the 1830s, smallpox and malaria had decimated the native population. The following decades brought increasing colonization of the area and the beginnings of the modern agricultural pattern.

American colonization of the Sacramento Valley began during the Mexican Rancho era. John Bidwell, Peter Lassen, and John Parrot

were among those awarded a Mexican Land Grant, which included Rancho del Arroyo Chico, Rancho Bosquejo, and Rancho Llano Seco, respectively. Statehood came soon after gold was discovered by James Marshall at Sutter's Mill on the American River. Thousands of fortune seekers immigrated to California and those supplying goods and services to the miners realized economic success. The early ranches and farms provided vital agricultural commodities which helped expand settlement. People and freight were transported by wagon and steamboat. Thirteen ferries were located along the Sacramento River between Red Bluff and Colusa. River travel by steamboat was a practical mode of transportation because river boats could efficiently transport agricultural freight and the valley oak forests and woodlands supplied an abundance of fuel to power these paddle-wheeled steam boats. Ferries, river boat landings, and bridges all played a key roll in the locations of towns and the development of a system of roads. Improved roads and the railroad system eventually replaced river boat travel.

Agriculture was first and foremost the central economic force in the Sacramento Valley. Dry land grain farming was the earliest agricultural practice. Row crops, orchards, rice, and irrigated pasture flourished when abundant water from the Sacramento River and its tributaries irrigated the fertile alluvial soils of the floodplain and basins. Water was distributed to farms through a system of river and stream diversions and water delivery canals. The development of the centrifugal pump in the early 20th century facilitated the expansion of irrigated lands through ground water pumping. Finally, State and Federal water projects for land reclamation, irrigation and urban water supply, and flood control allowed for further agricultural and urban expansion and the industries that followed.

Sacramento Refuge was established in 1937, encompassing the extensive holdings of the Spalding Ranch. A Civilian Conservation Corps (CCC) camp was assigned to the Refuge to transform the wheat and rice fields into a series of ponds for waterfowl. The CCC also began altering the ranch buildings for use as the Refuge Headquarters. For the most part, ranch buildings were torn down and the materials salvaged. The CCC extensively altered the original 1910s ranch house in 1939 to create a "modern" residence (Quarters No. 1) for the refuge manager. The garage was also remodeled from an existing building in 1939. A lookout tower, two service buildings, carpenter shop, water tower, a "caretaker's" residence (Quarters No. 2), and an office were constructed between 1937 and 1942.

Refuge manager's residence (1939)
USFWS photo

In 1980, the Service prepared a determination of eligibility for the buildings at the Sacramento Refuge headquarters for inclusion in the National Register of Historic Places (NRHP) based on its association with the CCC and early development of the Refuge (Criterion A) (Osugi 1980; Speulda and Donovan 2003). The California State Historic Preservation Office concurred with the Service's determination of eligibility, and it was subsequently forwarded to the Keeper of the NRHP for review. Although the Keeper found that the buildings were "undistinguished," he concurred that the Complex as a whole was eligible as a district under Criterion A because of its association with the CCC and noted that "this camp is of exceptional significance in the field of conservation…[it] served as the headquarters for several wildlife conservation areas within the Sacramento River basin and is an important survivor from the early period of the Federal Government's involvement in wildlife conservation."

Although formal nomination of the district to the NRHP was never completed, the buildings remain "eligible" and therefore continue to be treated as historic properties. Of the original buildings and structures evaluated for inclusion in the NRHP, one storage building was destroyed by fire in 1984; three grain bins rusted out and were removed in 1990; the flagpole fell down and was removed in 1998; and one residence and the garage were demolished in 2004 after development of a Memorandum of Agreement in coordination with the State of California, Office of Historic Preservation. The seven remaining buildings and structures include a residence, equipment storage building, office, water tower, observation tower, carpenter shop, and CCC Camp sign.

Sacramento Refuge buildings (1940)
USFWS photo

The exterior of the remaining residence has been altered over the years, although the interior retains many of the CCC-era workmanship elements. The office has been modified extensively over the past 65 years. Although still retaining most of their original features, the equipment storage building, water tower, observation tower, and carpenter shop are in need of extensive repairs to

maintain their functionality and historic integrity. The CCC Camp sign is in storage and the sign support structure remains at the original site.

In addition to the Sacramento Refuge CCC Headquarters Complex district evaluation, cultural resource investigations conducted to date on the Refuges have included three narrow surveys that examined small portions of Delevan, Colusa, and Sutter Refuges prior to the occurrence of management activities being conducted on specific project locations. These surveys generally consisted of single person meandering pedestrian transects which covered the project areas. No cultural resources were identified during these surveys.

The Service, like other Federal agencies, is legally mandated to inventory, evaluate, and protect cultural resources located on those lands that the agency owns, manages, or controls. The Service's cultural resource policy is delineated in 614 FW 1-5 and 126 FW 1-3 of the Service Manual. Field stations initiate the cultural resource review and compliance process by contacting the Regional Historic Preservation Officer/Regional Archaeologist (RHPO/RA). The RHPO/RA determines whether the proposed undertaking has the potential to impact cultural resources, identifies the "area of potential effect," determines the appropriate level of scientific investigation necessary to ensure legal compliance, and assists the field station in initiating consultation with the pertinent State Historic Preservation Office (SHPO) and federally recognized Tribes.

15. Social and Economic Environment

15.1. Transportation

Major transportation routes in the vicinity of the Refuges include Interstate 5, State highways 99, 45, 162, 20, and county route 99W. Many small paved county roads provide for local transportation, offering service access to local agricultural activities. These, and the large interstate and highways, provide access to Refuge visitor contact stations and parking lots. There are no alternative transportation systems that provide access to the Refuges.

American coot
Photo by Steve Emmons

15.2. Employment

California has a $1.4 trillion gross state product, which makes it the largest state economy in the nation and the fifth largest economy in the world (California Department of Transportation 2005). The 2005-2025 County-Level Economic Forecast (California Department of Transportation 2005) reported that the state has 14.9 million wage and salary jobs. In 2004, 139,500 jobs were created, 97 percent of which came from the non-farm sector. The unemployment rate declined to 6.2 percent. The per capita income in California is $34,220 and the average salary per worker is $49,690. Employment growth is expected to increase over the next several years.

The unemployment rate is one of the best ways to measure the economic health of a region. The Great Valley Center's report on "Assessing the Region Via Indicators: The Economy" (2005), states that while unemployment in the Central Valley remains substantially higher than the rest of California, the difference has decreased slightly since 1998. From 1994 to 1998, the Central Valley's unemployment rate averaged 11.9 percent, which was 4.8 percentage points higher than the State rate. From 1999 to 2003, the Central Valley unemployment averaged 10 percent, which was 4.2 percentage points higher than the State rate.

Agriculture is a critical part of the economy in Glenn County. In 2004, agriculture was responsible for 20 percent of total employment, and total crop production was valued at over $327 million (California Department of Transportation 2005). State/local government is the largest employment sector and agriculture is the second (employing 1,520 people) (California Department of Finance 2002). The 2005-2025 County-Level Economic Forecast (California Department of Transportation 2005) reported that Glenn County had 7,580 wage and salary jobs increasing 5.1 percent (369 jobs) from the previous year. Non-farm employment added 142 jobs, while farm employment added 227 jobs. The unemployment rate, declined to 9.4 percent in 2004. Employment growth is expected to increase over the next several years, as a result of growth in the non-farm sector.

Colusa County is the most productive rice growing county in the nation (New Valley Connexions 2001). Agriculture is the largest employment sector (employing about 2,540 people) and State/local government is second (California Department of Finance 2002). The 2005-2025 County-Level Economic Forecast (California Department of Transportation 2005) reported that Colusa County had 7,480 wage and salary jobs increasing 1 percent (77 jobs) from the previous year. Non-farm employment added 42 jobs, while farm employment added 35 jobs. The unemployment rate declined to 13.6 percent in 2004. Employment growth is expected to increase over the next several years.

In Sutter County, trade and services is the largest employment sector, agriculture is second (employing 6,200 people), and State/local government is third (California Department of Finance 2002). The 2005-2025 County-Level Economic Forecast (California Department of Transportation 2005) reported that Sutter County had 26,940 wage and salary jobs increasing 0.6 percent (160 jobs) from the previous year. Non-farm employment added 440 jobs, while farm employment lost 280 jobs. The unemployment rate declined to 10.6 percent in 2004. Employment growth is expected to increase over the next several years, as a result of growth in the non-farm sector.

15.3. Local Economy

Agriculture is the dominant economic enterprise in the northern Sacramento Valley and provides nearly 20 percent of the jobs in the Central Valley. The diversity of crops grown in the Sacramento Valley reflects the diversity of soils, climate, cultural and economic factors. Glenn County's major crops include rice, almonds, prunes, and corn; Colusa County's include rice, tomatoes, and almonds; and Sutter County's include rice, plums, peaches, walnuts, and tomatoes. Countywide agricultural production values are $280.9 million for Glenn; $346 million for Colusa, and $343 million for Sutter (California Department of Finance 2002).

The 2005-2025 County-Level Economic Forecast (California Department of Transportation 2005) reported that Glenn County's per capita income is $21,210, and the average salary per worker is $30,780. Colusa County's per capita income is $27,690, and the average salary per worker is $31,450. Sutter County's per capita income is $26,940, and the average salary per worker is $32,150.

The report "Banking on Nature 2006: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation" (USFWS 2007b) detailed the findings from 80 national wildlife refuges, including Sacramento Refuge. The Banking on Nature 2006 study included money spent for food and refreshments, lodging at motels, cabins, lodges or campgrounds, and transportation when it calculated the total economic activity related to refuge recreational use.

According to the report (USFWS 2007b), Sacramento Refuge had over 137,430 visits in 2006. Refuge visitors enjoyed a variety of activities, including wildlife viewing, hiking, and migratory bird hunting. Non-residents accounted for about 127,408 or 93 percent of recreation visits and almost all of the visits were for non-consumptive recreations (129,257). Sacramento Refuge generated an estimated $2.4 million in total economic activity related to refuge recreational use with associated employment of 25 jobs, $773,500 in employment income and $391,100 in total tax revenue. Total expenditures were $1.8 million with non-residents accounting for $1.7 million or 96 percent of total expenditures. Expenditures on hunting accounted for 57 percent of all expenditures, and non-consumptive activities

accounted for 43 percent. Sacramento Refuge generated $2.78 of recreation-related benefits for every $1 of budget expenditure during 2006.

Cinnamon teal
Photo by Mike Peters

The report (USFWS 2007b) also states recreational visits to national wildlife refuges generate substantial economic activity. In 2006, 34.8 million people visited refuges in the lower 48 states for recreation. Their spending generated almost $1.7 billion of sales in regional economies. As this spending flowed through the economy, nearly 27,000 people were employed and $542.8 million in employment income was generated. In addition, refuge recreational spending generated about $185.3 million in tax revenue at the local, county, state and Federal level. About 82 percent of total expenditures are generated by non-consumptive activities on refuges. Fishing accounted for 12 percent and hunting 6 percent. Local residents accounted for 13 percent of expenditures while visitors coming from outside the local area accounted for 87 percent.

15.4. Land Use and Zoning

The Refuges are bordered primarily by private lands. Private lands are mostly agricultural land (rice, orchards, row crops), with some private duck-hunting clubs, farmsteads, businesses, trailer parks, and isolated homes.

Each of the three counties in which the Refuges are located has its own General Plan that outlines land use policies. The portions of Glenn, Colusa, and Sutter counties' General Plans that relate to management of the Refuges are summarized in Appendix M.

15.5. Demographics

In the first 150 years of statehood, California grew from fewer than 100,000 citizens in 1850 to almost 34 million in 2000 (California Department of Finance 2002). Between 1950 and 2000 alone, California's population increased by 200 percent (California Department of Finance 2002). If California continues to add nearly 500,000 persons each year, by 2012, the population could easily

exceed 40 million. The 50-million mark will be passed sometime between 2030 and 2040 if current growth rates persist (California Department of Finance 2002).

The Central Valley has been one of the fastest growing areas in California during the last few decades. As of July 1997, the Central Valley had seventeen percent of the State's population (Munroe and Jackman 1999).

In 2005, Glenn County's population was 28,197 and is expected to increase to 32,000 residents by 2020 (California Department of Finance 2005). The racial makeup of the county was 71.8 percent white, 29.6 percent Hispanic, 3.4 percent Asian, 2.1 percent Native American, 0.6 percent African American, with the remaining percentage from other races (Percentage total can be greater than 100 percent because Hispanics can be counted in multiple races, U.S. Census Bureau 2000). The estimated median family income was $32,107.

Colusa County is home to 20,800 residents and is projected to increase to 26,000 residents by 2020 (California Department of Finance 2005). The racial makeup of the county was 64.3 percent white, 46.5 percent Hispanic, 2.3 percent Native American, 1.2 percent Asian, 0.5 percent African American, with the remaining percentage from other races (Percentage total can be greater than 100 percent because Hispanics can be counted in multiple races, U.S. Census Bureau 2000). The estimated median family income was $35,062.

Sutter County's population was 88,945 people and is expected to increase to 112,000 people by 2020 (California Department of Finance 2005). The racial makeup of the county was 67.5 percent white, 22.2 percent Hispanic, 11.3 percent Asian, 1.9 percent African American, 1.6 percent Native American, with the remaining percentage from other races (Percentage total can be greater than 100 percent because Hispanics can be counted in multiple races, U.S. Census Bureau 2000). The estimated median family income was $38,375.

Greater white-fronted goose
Photo by Steve Emmons

Chapter 4 Planned Refuge Management and Programs

Overview of Goals, Objectives, and Strategies

One of the most important parts of the CCP process is the development and refinement of the Refuges' vision and goals. This section contains the primary goals that will define the management direction of the Refuges for the next 15 years. In addition, as part of the CCP, the Refuges are expected to develop objectives and strategies that, together, will help achieve the goals. *Goals* are broad statements of the desired future conditions for refuge resources. Refuge goals may or may not be feasible within the 15-year time frame of the CCP. Whenever possible, *objectives* are quantified statements of a standard to be achieved or work to be accomplished. They should be specific, measurable, achievable, results-oriented, and time-fixed, and should be feasible within the 15-year lifespan of the CCP. *Strategies* are specific actions, tools, or techniques that contribute toward accomplishing the objective. In some cases, strategies describe specific projects in enough detail to assess funding and staffing needs.

The five goals of the Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges are outlined below to provide a context for the proposed management direction.

Goal 1: Wildlife and Habitat Goal

Conserve, manage, restore, and enhance habitats and associated plant and wildlife species, with an emphasis on supporting an abundance and natural diversity of wintering and migrating waterfowl, shorebirds, birds of prey, and songbirds.

Goal 2: Threatened and Endangered Species Goal

Conserve, manage, restore, and enhance threatened and endangered species and their habitats including vernal pool plants and invertebrates, and giant garter snakes.

Goal 3: Visitor Services Goal

Provide visitors of all ages and abilities with quality wildlife-dependent recreation (hunting, wildlife observation, photography, environmental education, and interpretation), and volunteer opportunities to enhance public appreciation, understanding, and enjoyment of fish, wildlife, habitats, and cultural resources.

Goal 4: Partnership Goal

Promote partnerships to preserve, restore, and enhance a diverse, healthy, and productive ecosystem in which the Refuges play a key role.

Goal 5: Resource Protection Goal

Adequately protect and maintain all natural and cultural resources, staff and visitors, equipment, facilities, and other property on the Refuges.

Organization

Each objective and strategy are given a unique numeric code for easy reference. Objectives have a two-digit code (e.g., 1.1, 1.2, 2.1, 2.2). The first digit corresponds to the goal to which the objective applies. The second digit is sequential. Similarly, each strategy has a three-digit code (e.g., 1.1.1, 1.1.2, 2.1.1, 2.1.2). The first and second digits refer to the appropriate goal and objective, respectively. The third digit is sequential.

Refuge Management Goals, Objectives, and Strategies

1. Wildlife and Habitat Goal

Conserve, manage, restore, and enhance habitats and associated plant and wildlife species, with an emphasis on supporting an abundance and natural diversity of wintering and migrating waterfowl, shorebirds, birds of prey, and songbirds.

1.1. Managed Wetland Habitat Objective

Collectively on the four Refuges, actively manage 16,914 wetland habitat acres to provide 80 to 90 percent seasonally flooded wetlands and 10 to 20 percent summer wetlands, starting in 2008. Seasonally flooded wetlands will contain 5 to 50 percent tall emergent cover, $\geq$50 percent desirable forage plant species cover, and an average water depth of 12 inches (range of 1 to 36 inches). Summer wetlands units will contain 40 to 70 percent cover of desirable submergent or floating-leaved emergent species. At least 50 percent of summer wetland units will have 30 to 80 percent tall emergent cover and average water depths of 24 inches (range of 12-36 inches) during May-October and $\leq$18 inches during November-April.

Rationale: Wetlands support the greatest abundance and diversity of wildlife on the Refuges. Freshwater wetlands have declined by 90 to 95 percent in the Central Valley (Holland 1978; 1998; Gilmer et al. 1982; Frayer et al. 1989; Kempka and Kollasch 1990). The North American Waterfowl Management Plan (USFWS et al. 1986, 1998) and the Central Valley Joint Venture (CVJV) Implementation Plan (CVJV 2006) address population and habitat objectives for healthy waterfowl populations. This objective also helps to achieve Central

Valley and Bay-Delta Region Conservation Actions C and L in the California Wildlife Action Plan (CDFG 2005c). Refuge management strategies will support these objectives. Managed wetlands are an essential component upon which significant numbers of waterfowl, waterbirds, shorebirds, other birds, threatened and endangered species rely.

Climate change is already affecting wildlife throughout the state (Parmesan and Galbraith 2004), and its effects will continue to increase, it has particular significance for this region's major river systems. For the Central Valley, this means more intense winter flooding, greater erosion of riparian habitats, and increased sedimentation in wetland habitats (Field et al. 1999, Hayhoe et al. 2004). Hotter, drier summers, combined with lower river flows, will dramatically increase the water needs of both people and wildlife. This is likely to translate into less water for wildlife, especially fish and wetland species.

Managed Wetland Habitat Strategies

1.1.1. Incorporate wetland management into annual habitat management planning process.

1.1.2. Actively manipulate water levels on seasonally flooded wetlands and summer wetlands consistent with annual Habitat Management Plans.

1.1.3. Restore, rehabilitate or enhance at least 10 percent of the wetland habitat annually.

1.1.4. Use mowing, disking, deleveling, prescribed fire (approximately 1,500 acres/year), herbicides, and grazing to manage and enhance wetland habitat.

1.1.5. Maintain water control infrastructure.

1.1.6. Conduct and evaluate wetland vegetation surveys annually.

1.1.7. Conduct and evaluate regular wildlife surveys to assess wildlife use of wetland habitats.

1.1.8. Support and facilitate management-oriented research on wetland habitat, including monitoring the impacts of climate change.

1.1.9. Hire full-time wildlife biologist, purchasing agent, office automation clerk, tractor operator, prescribed fire specialist, fire budget technician, and two engineering equipment operators to implement wetland habitat management an support other habitat objectives.

1.1.10. Hire one full-time computer specialist to implement wetland habitat management and support Goal's 1-5.

1.2. Vernal Pool/Alkali Meadow Habitat Objective

Protect and enhance 4,021 acres of vernal pool/alkali meadow habitat comprised of ≥60 percent native plant species cover by 2013.

Rationale: In combination, vernal pools and alkali meadow habitats support the greatest percentage of rare, endemic, and Federal and State listed species on the Refuges. Approximately 75 percent of all vernal pools in the Central Valley were lost by 1997 (Holland 1978, 1998). Early losses were primarily related to conversion to agriculture croplands. Losses that are more recent have been a result of conversion of historic cattle grazing lands to other uses and widespread urbanization (USFWS 1998, 2005). Vernal pool/alkali meadow conservation, management, and restoration are among the mandated purposes of the Refuges. This objective also helps to achieve Central Valley and Bay-Delta Region Conservation Action C in the California Wildlife Action Plan (CDFG 2005c).

Vernal pool on Sacramento Refuge
Photo by Joe Silveira

Vernal Pool/Alkali Meadow Habitat Strategies

1.2.1. Incorporate vernal pool/alkali meadow management into annual habitat management planning process.

1.2.2. Use prescribed fire (approximately 200 acres/year), herbicides, and grazing as primary methods to reduce and control non-native and invasive plant species in vernal pool/alkali meadow habitat.

1.2.3. Protect hydrology of vernal pool/alkali meadow habitat by controlling runoff from surrounding flooded lands.

1.2.4. Restore Tract 24.12 (32 acres) and Tract 26 (60 acres) to vernal pool/alkali meadow habitat on Colusa Refuge.

1.2.5. Restore Tract 1.1 (73 acres) to vernal pool/alkali meadow habitat on Delevan Refuge.

1.2.6. Restore additional acres of vernal pool/alkali meadow habitat as opportunities arise. Use plant materials (i.e., seeds, cuttings) derived from local ecotypes to construct natural plant communities, which may support locally rare native plants, endemic species, and threatened and endangered species.

1.2.7. When restoring vernal pool/alkali meadow habitats, implement restoration for species identified in the vernal pool recovery plan when and where possible (refer to Threatened and Endangered Species Strategies).

1.2.8. Conduct and evaluate regular wildlife surveys to assess wildlife use of vernal pool/alkali meadow habitats.

1.2.9. Conduct and evaluate periodic vernal pool/alkali meadow vegetation surveys.

1.2.10. Support restoration and management-oriented research on vernal pool/alkali meadow habitats.

1.3. Grassland Habitat Objective

Protect and enhance 1,267 acres of grassland habitat comprised of ≥60 percent native plant species cover by 2013.

Rationale: Perennial and annual grasslands provide numerous important habitat components, including foraging areas, nesting, thermal and escape cover, for a variety of wildlife species on the Refuges. Less than one percent of California's original grasslands remain (Huenneke 1989) due to conversion to cropland, development, wildfire suppression, and introduction of nonnative plant species. The Grassland Bird Conservation Plan (CPIF 2000) has addressed population and habitat objectives for healthy grassland bird populations. Refuge management strategies will support these objectives. This objective also helps to achieve Central Valley and Bay-Delta Region Conservation Action C and Statewide Conservation Action H in the California Wildlife Action Plan (CDFG 2005c).

Grassland Habitat Strategies

1.3.1. Incorporate grassland management into annual habitat management planning process.

1.3.2. Conserve, protect, enhance, and restore a variety of perennial and annual grasslands, where appropriate, based on soils, hydrology, or other features.

1.3.3. Use mowing, disking, prescribed fire (approximately 200 acres/year), herbicides, and grazing, or other appropriate treatments to reduce and control non-native and invasive plant species, enhance and maintain native species composition, and provide a mix of tall or short grassland structure.

1.3.4. Protect hydrology of grassland habitat by controlling runoff from surrounding flooded lands.

1.3.5. Restore Tract 44.3 (40 acres) to native grasslands on Delevan Refuge.

1.3.6. Restore additional acres to native grasslands using plant materials (i.e., seeds, cuttings) derived from local ecotypes as opportunities arise.

1.3.7. Enhance topographic features for selected wildlife species (burrowing owl, etc.).

1.3.8. Conduct and evaluate regular wildlife surveys to assess wildlife use of grassland habitats.

1.3.9. Conduct and evaluate periodic grassland vegetation surveys.

1.3.10. Support management-oriented research on grassland habitats.

1.4. Riparian Habitat Objective

Protect and enhance 581 acres of riparian habitat comprised of $\geq$80 percent native woody vegetation and herbaceous cover by 2013.

Rationale: Wetlands and riparian forests once covered about five million acres of the Central Valley before intensive settlement began in the late 1800s. Flood-control and subsequent conversion of natural wetlands to agricultural production have reduced these habitats to less than one-tenth their former extent (Dahl 1990). Less than two percent of the pre-1850 acreage of riparian forest remains, with virtually all of the Valley oak forest type gone (Bay Institute 1998).

Riparian forests and other riparian plant communities of California's Central Valley provide habitat for a diversity of resident and migratory terrestrial and aquatic wildlife, including rare and endangered species (Gaines 1974, 1977; Moyle 2002; Riparian Habitat Joint Venture 2004; Roberts et al. 1977; Small et al. 2000) The Partners in Flight North American Landbird Conservation Plan (Rich et al. 2004), the California Partners in Flight/Riparian Habitat Joint Venture Riparian Bird Conservation Plan (2004), and CVJV Implementation Plan (2006) identify focal species and habitat conservation and restoration needs for Central Valley birds. Refuge management strategies will support these objectives. This objective also helps to achieve Central Valley and Bay-Delta Region

Conservation Actions C and L in the California Wildlife Action Plan (CDFG 2005c).

Riparian Habitat Strategies:

1.4.1. Incorporate riparian management into annual habitat management planning process.

1.4.2. Enhance riparian habitat by planting indigenous native trees and shrubs using local ecotypes when practicable and feasible on Colusa Refuge along Powell Slough and Tract 14 (5 acres).

1.4.3. Restore understory riparian habitat by planting indigenous native grasses, sedges, and forbs on Colusa Refuge.

1.4.4. Enhance riparian habitat by eliminating or reducing non-native and invasive trees and shrubs through manual removal and herbicide application.

1.4.5. Maintain cottonwood willow forest on Sacramento Refuge Tract 31.1 (Sherwood Forest) to provide habitat for breeding and migratory birds.

1.4.6. Conduct and evaluate regular wildlife surveys to assess wildlife use of riparian habitats.

1.4.7. Conduct and evaluate periodic riparian vegetation surveys.

1.4.8. Support management-oriented research on riparian habitats, including monitoring the impacts of climate change.

1.5. Sutter Bypass Management Objective

By 2008, actively manage 1,500 acres within the Sutter Bypass portion of Sutter Refuge to help prevent excessive accumulation of woody vegetation that may impact flood water conveyance capabilities. Begin implementation of a "Tree Reduction Operations Plan - Tract 1 Sutter National Wildlife Refuge" (Appendix P).

Rationale: The Sutter Bypass (Bypass) was constructed to provide conveyance for floodwaters. The Refuge, in cooperation with the Department of Water Resources (DWR), Sutter County, and other interested parties, will implement Best Management Practices (BMPs) listed below to avoid reduction in floodwater conveyance capacity in the Bypass. The focus of the tree/shrub reduction efforts will continue to be within the managed wetland units, especially those within the center "alley" of Sutter Refuge. Groups of trees/shrubs with an east-west orientation will be considered the highest priority for removal and maintenance throughout the Bypass. Because the "Northwest Grove" in the Tract 1 upland has filled in extensively since the 1960's, a specific operational plan focusing on tree and understory reduction in that area has been developed (Appendix P).

The trees bordering the east and west borrow channels along the entire length of the Refuge within the Bypass will remain.

Sutter Bypass Management Strategies:

1.5.1. Work closely with DWR, Sutter County, and Central Valley Flood Protection Board (aka State Reclamation Board) staff on floodplain management issues at Sutter Refuge. Provide each agency with copies of annual habitat management plans.

1.5.2. Implement BMPs throughout the managed wetlands in the Bypass. Woody vegetation will comprise no more than five percent of the aerial cover between the bordering tree lines. Management efforts will be adaptive and utilize the following:

- Within wetland management units, focus efforts on groups or lines of trees running perpendicular to flood flows using mechanical, chemical, livestock grazing or prescribed fire removal/maintenance methods.

- Within wetland management units, target saplings when disking and use herbicides and/or mechanical removal to control mid-sized trees/shrubs (trees established after the 2001 tree removal effort).

- Work cooperatively with DWR to spray herbicide on re-growth of selected woody vegetation.

- Control new woody growth (established after the 2005 removal work) between the "Northwest Grove" and the road to the northeast gate using mechanical, chemical, livestock grazing or prescribed fire.

- Remove all non-native trees throughout the Bypass portion of the Refuge.

- Monitor the effects of vegetation removal/control on wildlife and habitat.

1.5.3. Work cooperatively with DWR and others to begin implementation of the "Tree Reduction Operations Plan-Tract 1 Sutter National Wildlife Refuge" (Appendix P) in an effort to improve flood flows through the "Northwest Grove".

1.5.4. Maintain the forests on the east and west borrow channels as habitat for migratory birds, including western yellow-billed cuckoos, at 2006 levels. Do not allow the forests to expand into the adjacent wetlands.

1.6. Wintering Waterfowl Objective

Conduct eleven annual and periodic surveys in order to assess trends in the abundance, distribution, recruitment, and health of wintering waterfowl on the Refuges, Central Valley, and Pacific Flyway.

Rationale: Migratory birds are Federal trust species under the jurisdiction of the Service. Many species of migratory and resident birds depend on wetlands for winter habitat. Their conservation, management, and restoration are among the mandated purposes of the Refuges. Freshwater wetlands have declined by 90 to 95 percent in the Central Valley (Holland 1978; Gilmer et al. 1982; Frayer et al. 1989; Kempka and Kollasch 1990). The North American Waterfowl Management Plan (USFWS et al. 1986, 1998), CVJV Implementation Plan (CVJV 2006), and Pacific Flyway Management Plans (Pacific Flyway Council 2007) address population and habitat objectives for healthy waterfowl populations. Refuge management strategies will support these objectives. The Refuges provide wintering habitat for waterfowl. Monitoring is necessary to determine population status, assess trends, and identify habitat use, as well as restoration and management needs.

Blue morph snow goose
Photo by Mike Peters

Wintering Waterfowl Strategies:

1.6.1. Conduct regular wildlife surveys on Refuges one to two times a month.

1.6.2. Coordinate with Pacific Flyway entities including Division of Migratory Bird Management (DMBM), California Department of Fish and Game (CDFG), U.S. Geological Survey (USGS) National Wildlife Health Lab, and other organizations to conduct survey and monitoring efforts.

1.6.3. Conduct and report results from annual fall and winter waterfowl surveys, including special tule goose, white-fronted goose, dark goose, white goose, and midwinter waterfowl surveys.

1.6.4. Conduct periodic white-goose species composition surveys.

1.6.5. Annually monitor abundance and distribution of Aleutian cackling geese in the Sacramento Valley.

1.6.6. Collect data on age ratios of Arctic nesting geese for annual Flyway Productivity of Geese and Swans Report.

1.6.7. Monitor and control avian disease outbreaks.

1.6.8. Conduct or facilitate banding and marking of wintering waterfowl for population assessment.

1.6.9. Support management-oriented research on wintering waterfowl.

1.7. Breeding Waterfowl Objective

Implement four monitoring surveys annually for breeding waterfowl on wetland habitats of the Refuges.

Rationale: Migratory birds are Federal trust species under the jurisdiction of the Service. Many species of migratory and resident birds depend on wetlands for breeding habitat. Their conservation, management, and restoration are among the mandated purposes of the Refuges. Freshwater wetlands have declined by 90-95 percent in the Central Valley (Holland 1978, 1998, Gilmer et al. 1982, Frayer et al. 1989, Kempka and Kollasch 1990). The North American Waterfowl Management Plan (USFWS et al. 1986, 1998) and the CVJV Implementation Plan (CVJV 2006) address population and habitat objectives for healthy waterfowl populations. Refuge management strategies will support these objectives. The Refuges provide breeding habitat for waterfowl. Monitoring is necessary to determine population status, assess trends, and to identify habitat use as well as restoration and management needs.

Breeding Waterfowl Strategies:

1.7.1. Conduct regular wildlife surveys on Refuges one to two times a month.

1.7.2. Conduct pre-season waterfowl banding in accordance with the Pacific Flyway Project, to meet or exceed established quotas.

1.7.3. Maintain and monitor wood duck boxes on the Refuges.

1.7.4. Evaluate Refuge waterfowl nesting, brood rearing, and molting habitat.

1.7.5. Monitor and control avian disease outbreaks.

1.7.6. Support management-oriented research on breeding waterfowl.

1.8. Shorebird Objective

Conduct annual (two) and periodic surveys in order to assess trends in the abundance, distribution, and health of shorebirds on the Refuges and in the Central Valley.

Rationale: Migratory birds are Federal trust species under the jurisdiction of the Service. Many species of migratory and resident birds depend on wetlands for winter habitat. Freshwater wetlands have declined by 90 to 95 percent in the Central Valley (Holland 1978, 1998; Gilmer et al. 1982; Frayer et al. 1989; Kempka and Kollasch 1990). The U.S. Shorebird Conservation Plan, Southern Pacific Shorebird Conservation Plan (Hickey et al. 2003), and CVJV Implementation Plan (CVJV 2006) addresses population and habitat objectives for healthy shorebird populations. Refuge management strategies will support these objectives. The Refuges provide wintering, migration, and breeding habitat for shorebirds. Monitoring is necessary to determine population status, assess trends, and identify habitat use, as well as restoration and management needs.

Greater yellowlegs
Photo by Steve Emmons

Shorebird Strategies:

1.8.1. Conduct regular wildlife surveys on Refuges one to two times a month.

1.8.2. Coordinate and conduct shorebird surveys with Central Valley Joint Venture.

1.8.3. Monitor and control avian disease outbreaks.

1.8.4. Support management-oriented research on shorebirds.

1.8.5. Manage wetlands to optimize shorebird use during peak use times, such as spring migration.

1.9. Other Waterbird Objective

Conduct three surveys annually in order to assess trends in the abundance, distribution, and health of other waterbirds on the Refuges.

Rationale: Migratory birds are Federal trust species under the jurisdiction of the Service. Many species of migratory and resident birds depend on wetlands for winter habitat. Freshwater wetlands have declined by 90 to 95 percent in the Central Valley (Holland 1978, 1998; Gilmer et al. 1982; Frayer et al. 1989; Kempka and Kollasch 1990). The North American Waterfowl Management Plan (USFWS et al. 1986, 1998) and the CVJV Implementation Plan (CVJV 2006) address population and habitat objectives for focal species of waterbirds. Refuge management strategies will support these objectives. The Refuges provide breeding and wintering habitat for egrets, herons, rails, ibises, grebes, and other waterbirds. Monitoring is necessary to determine population status, assess trends, and identify habitat use, as well as restoration and management needs.

Other Waterbird Strategies:

1.9.1. Conduct regular wildlife surveys on Refuges one to two times a month.

1.9.2. Monitor colonial waterbird rookery locations, size, and reproductive success.

1.9.3. Conduct periodic surveys with CDFG for selected species, including sandhill crane.

1.9.4. Monitor and control avian disease outbreaks.

1.9.5. Support management-oriented research on waterbirds.

1.9.6. Manage wetlands to optimize nesting and foraging habitat and successful breeding of waterbirds.

1.10. Other Bird Objective

Conduct six surveys annually in order to assess trends in the abundance, distribution, and health of landbird birds on the Refuges.

Rationale: Migratory birds are Federal trust species under the jurisdiction of the Service. The Refuges provide habitat for migratory and resident birds. Monitoring is necessary to determine population status, assess population trends, determine causes for poor productivity, identify solutions, determine habitat restoration needs, and assess restoration success.

Other Bird Strategies

1.10.1. Conduct regular wildlife surveys on Refuges one to two times a month.

1.10.2. Conduct periodic surveys with cooperating agencies for selected species, including tri-colored blackbird, yellow-billed cuckoo, and burrowing owl.

1.10.3. Conduct golden eagle nest success survey at Sacramento Refuge.

1.10.4. Conduct pheasant brood surveys at Sacramento, Delevan, and Colusa Refuges.

1.10.5. Monitor and control avian disease outbreaks.

1.10.6. Support management-oriented research on other birds.

1.11. Anadromous Fisheries and Native Fisheries Objective

By 2013, annually implement BMPs and water management strategies to provide for native fish life cycle needs on the Refuges.

Rationale: The Service and the Refuge System each identify anadromous fish conservation in their mission statements. The Sacramento River system supports four distinct salmon runs making Chinook salmon and Central Valley steelhead important ecological, recreational, and commercial fisheries. The east and west Sutter Bypass canals are part of the lower Butte Creek and are tributary to the larger Sacramento River system. Adult salmon and steelhead migrate up the Sutter Bypass canals at various times of the year depending upon the run.

Floodplain productivity is important to immature salmonids and other native fishes that escape from large predatory fish in shallow waters. When inundated, the relatively warmer waters of the floodplain become very productive and produce an abundance of prey. Juveniles also return through the Sutter Bypass and may use the canal and Refuge wetlands, depending upon flood conditions.

Anadromous Fisheries and Native Fisheries Strategies:

1.11.1. Coordinate with Department of Water Resources (DWR) to keep the weirs clean in the Sutter Bypass.

1.11.2. Obtain Central Valley Project Improvement Act (CVPIA) water delivery for Sutter Refuge.

1.11.3. Continue to provide and monitor the flow-through water management system at Sutter Refuge to prevent entrapment of native fish.

1.11.4. Maintain water conveyance systems on Refuges.

1.11.5. Implement BMPs for mosquito control and herbicide applications (IPM Plan, Appendix F) on Refuges.

1.12. Exotic, Invasive Species Control Objective

Treat exotic invasive species using prescribed fire, grazing, herbicide treatment, mowing, disking, or other proven techniques on 8,000 acres of the Refuges annually as described in the Integrated Pest Management Plan (Appendix F).

Rationale: Invasive non-indigenous (exotic) species have become the single greatest threat to the Refuge System and the Service's wildlife conservation mission. More than eight million acres within the Refuge System are infested with invasive weeds (Audubon 2002). Invasive species cause widespread habitat degradation, compete with native species, and contribute significantly to the decline of trust species (USFWS 2002b). The National Strategy for Management of Invasive Species (USFWS 2002b) has been developed within the context of the National Invasive Species Management Plan, as called for by Presidential Executive Order 13112, and functions as the internal guidance document for invasive species management throughout the Refuge System. This Plan has four goals: 1) Increase the awareness of invasive species issues, both internally and externally; 2) Reduce the impacts of invasive species to allow the Refuge System to more effectively meet its fish and wildlife conservation mission and purpose; 3) Reduce invasive species impacts on the Refuge System's neighbors and communities; and 4) Promote and support the development and use of safe and effective integrated management techniques to deal with invasive species. This objective also helps to achieve Central Valley and Bay-Delta Region Conservation Actions C and P in the California Wildlife Action Plan (CDFG 2005c).

The Central Valley is occupied by a diversity and abundance of exotic, invasive species that are harmful because they crowd out or replace native species that are important to wildlife natural diversity and ecosystem function. These species often dominate old agricultural fields and early successional stages of restoration sites. In addition, some late successional stages of native vegetation are also dominated by these undesirable species. As a result, vegetation must be managed to control invasive exotic species so that species composition favors a diversity and abundance of native, indigenous plants.

Exotic, Invasive Species Control Strategies:

1.12.1. Annually evaluate invasive exotic species to be controlled (Table 6, Chapter 3). Locate, map, and monitor exotic species that may trigger a management response.

1.12.2. Control invasive and exotic species using prescribed fire, grazing, herbicide treatment, mowing, disking or other proven techniques as identified in the IPM plan (Appendix F).

1.12.3. Conduct, facilitate, and/or support research to identify invasive plant biology and ecology and to evaluate techniques for controlling invasive plant species.

1.12.4. Hire one full-time wildlife biologist to implement invasive species management.

1.13. Wildlife Sanctuary Objective

Provide 11,152 acres (47 percent of the Refuges total acres) of wetland, vernal pool/alkali meadow, grassland, and riparian habitats as sanctuary (i.e. no public access) for general wildlife use, nesting, sensitive breeding sites, and plant populations by 2008.

Rationale: Sanctuaries are areas on the Refuges that are closed to public use. They provide places where human-caused disturbances are reduced, thereby reducing the interruption of wildlife activities, such as foraging, resting, breeding, feeding nestlings, and other maintenance activities. Sanctuaries are especially important during high refuge visitor use periods. They are also important for wildlife to avoid predation by other wild animals, as they can devote less energy to avoiding humans and more to avoiding predators. Sanctuaries are areas where wildlife concentrate and reproduce, resulting in increased numbers of wildlife that can lead to more wildlife-dependent public use in areas near the sanctuary.

In some cases, short-term sanctuaries may be established to protect a sensitive nesting colony or site. These seasonal sanctuaries may impose public access restrictions at some nesting sites for species with a low tolerance for human disturbance (e.g. waterbird rookeries, tri-colored blackbird colonies, and golden eagle nest sites).

Waterfowl loafing in wildlife sanctuary
Photo by Mike Carpenter

Wildlife Sanctuary Strategies:

1.13.1. Provide strategically located sanctuaries on the Refuges for wildlife to feed and rest with relatively little human disturbance.

1.13.2. Provide sanctuaries to reduce human disturbance at sensitive fish, wildlife, and plant sites during the rearing, breeding, and growing seasons.

1.14. Mosquito Management Objective

Cooperatively monitor and manage pest mosquito species on 16,914 acres of managed wetlands, as described in the IPM Plan (Appendix F), by 2008.

Rationale: Local mosquito and vector control districts have identified a need to conduct mosquito monitoring and, if necessary, control activities on the Refuges in order to protect the public from any mosquito borne diseases. While mosquitoes are considered a nuisance because of their biting, some species are known vectors of serious diseases in California. There are primarily five mosquito species of concern potentially produced or harbored on the Refuges*: Aedes melanimon, Aedes nigromaculis, Aedes vexans, Culex tarsalis*, and *Anopheles freeborni*.

The main diseases of concern for mosquito control programs in northern California are Western Equine Encephalitis (WEE), St. Louis Encephalitis (SLE), California Encephalitis, West Nile Virus (WNV), and malaria (Appendix F). *Culex tarsalis* is the main vector identified in the transmission of these diseases, with the exception of malaria, which is vectored by *Anopheles freeborni* mosquitoes. The other mosquito species listed above can also potentially transmit WEE, SLE, and WNV, but are less competent vectors compared to *C. tarsalis*. WEE and SLE have caused significant outbreaks of human disease (CA Dept. of Health Services 2003). Public concern over human health issues related to mosquito-borne disease has intensified on the west coast with the advance of WNV across the United States, and its detection in California in 2003.

The Refuges have developed an IPM Plan (Appendix F) that outlines a risk-based, hierarchical approach to mosquito management. This approach uses an understanding of mosquito biology and ecology whereby intervention measures depend on continuous monitoring of mosquitoes.

The IPM approach ensures legitimate human, fish, and wildlife health concerns are addressed. It incorporates a combination of using a combination of best management practices (BMPs) in managed wetlands (Kwasny et al. 2004), biological controls, and a select group of pesticides, if warranted. Treatment thresholds (i.e. adult and larval mosquito population levels, and disease activity) and appropriate corresponding responses are identified (USFWS 2005b). Under this

program, if mosquito monitoring and disease surveillance indicate that human health thresholds are exceeded, the use of larvicides, pupicides, and/or adulticides may become necessary. In some cases, emergency actions may be required.

Mosquito Monitoring and Management Strategies

1.14.1. Work cooperatively with the local mosquito and vector control districts to monitor and manage pest mosquitoes consistent with National Policy, the Complex's IPM plan, and Compatibility Determinations.

1.14.2. Implement BMP's (Kwasney et al. 2004) for mosquito management on all habitat and water management activities.

2. Threatened and Endangered Species Goal

Conserve, manage, restore, and enhance threatened and endangered species and their habitats including vernal pool plants and invertebrates, and giant garter snakes.

2.1. Threatened & Endangered Species Objective

Monitor twelve Federal and State threatened and endangered species on 23,973 acres of Refuge lands annually by 2013.

Rationale: Federally listed threatened, endangered, and candidate species are trust responsibilities under the jurisdiction of the Service. Threatened and endangered species, as well as those proposed for Federal listing, are likely to become extinct due to environmental factors. The Refuges will help to achieve goals described in the Recovery Plan for Colusa grass, hairy Orcutt grass, Greene's tuctoria, Hoover's spurge, Conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp (USFWS 2005a), for palmate-bract bird's-beak (USFWS 1998), and in the Draft Recovery Plan for giant garter snake (USFWS 1999a).

Giant garter snake
USFWS photo

State threatened and endangered species have been identified as Birds of Conservation Concern by the Service, and are trust responsibilities of the Service under the Migratory Bird Treaty Act. Populations are in decline due, in part, to habitat degradation and destruction. Their conservation, management, and restoration are mandated purposes of the Refuges. Monitoring is necessary to determine population distribution, abundance, survival, habitat use, and to identify restoration and management needs. This objective also helps to achieve Central Valley and Bay-Delta Region Conservation Action C in the California Wildlife Action Plan (CDFG 2005c).

Threatened &Endangered Species Strategies

2.1.1. Document Refuge habitat use of Federal and State threatened and endangered species (palmate-bracted bird's-beak, hairy Orcutt grass, Greene's tuctoria, Hoover's spurge, Conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, giant garter snake, Swainson's hawk, greater sandhill crane, and western yellow-billed cuckoo) through regular, periodic, or specifically coordinated surveys.

2.1.2. Protect, conserve, maintain, enhance, and where appropriate restore habitat for threatened and endangered species.

2.1.3. Implement giant garter snake avoidance measures, including conducting surveys prior to any planned work activities where hibernation areas may be disturbed.

2.1.4. Support recovery activities for species identified in Fish and Wildlife Service recovery plans for palmate-bracted bird's-beak, giant garter snake, and vernal pool plant and animal species (USFWS 1998, 1999a, 2005).

2.1.5. Assist with the development and implementation of reintroduction and introduction programs to restore extirpated populations and protect individual species from the threat of extirpation due to random environmental or genetic events (USFWS 2005a) for the following: Colusa grass, palmate-bracted bird's-beak, hairy Orcutt grass, Green's tuctoria, Hoover's spurge, vernal pool saltbush, Ferris's milk-vetch, Conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, and other recovery plan species, as appropriate.

2.1.6. Support management-oriented research, such as the effects of various vegetation management techniques for the control of invasive plant species or describe soil and water characteristics (e.g., profile, texture, duripan, salinity/alkalinity) of species-specific reference pools for vernal pool habitat restoration/recovery projects.

2.1.7. Support research for actions identified in recovery plans that promote the recovery of threatened and endangered species such as: cooperative range-wide and directed population status and habitat condition surveys; seed/cyst collections/banking; genetics and demography for conservation and reintroduction/introduction; and effects of habitat management (USFWS 2005a, 2007a).

2.1.8. Provide annual and periodic Refuge monitoring survey information on listed species to appropriate State (CDFG State Office, Habitat Conservation Planning Branch, Region 2 Office) and Federal agencies (USFWS–Sacramento Fish and Wildlife Office, Permit Coordinator, Endangered Species and Recovery branches).

2.1.9. Support management-oriented research on threatened and endangered species.

2.1.10. Hire one full time and one part time wildlife biologist to implement endangered species management.

3. Visitor Services Goal

Provide visitors of all ages and abilities with quality wildlife-dependent recreation (hunting, wildlife observation, photography, environmental education, and interpretation), and volunteer opportunities to enhance public appreciation, understanding, and enjoyment of fish, wildlife, habitats, and cultural resources.

3.1. Hunting Objective

Implement a high quality hunting program including opportunities for approximately 22,000 annual hunting visits on 8,525 acres by 2023, depending on season length and climatic conditions.

Rationale: Hunting is identified in the Improvement Act as a priority public use that can be allowed when compatible with other Refuge purposes. As a result, the Refuges propose to continue hunting of waterfowl, coot, common moorhen, snipe, and pheasant. The hunting program will be conducted in a safe and cost-effective manner and will be carried out consistent with State regulations. The Hunting Plan (Appendix C) was developed to provide safe hunting opportunities, while minimizing conflicts with other priority wildlife-dependent recreational uses. Other visitor uses occur on different areas on the Refuges, thereby minimizing potential conflicts with hunters (Figures 11-14). The Refuge hunting program complies with the Code of Federal Regulations Title 50, 32.1 and is managed in accordance with Service Manual 605 FW 2, Hunting.

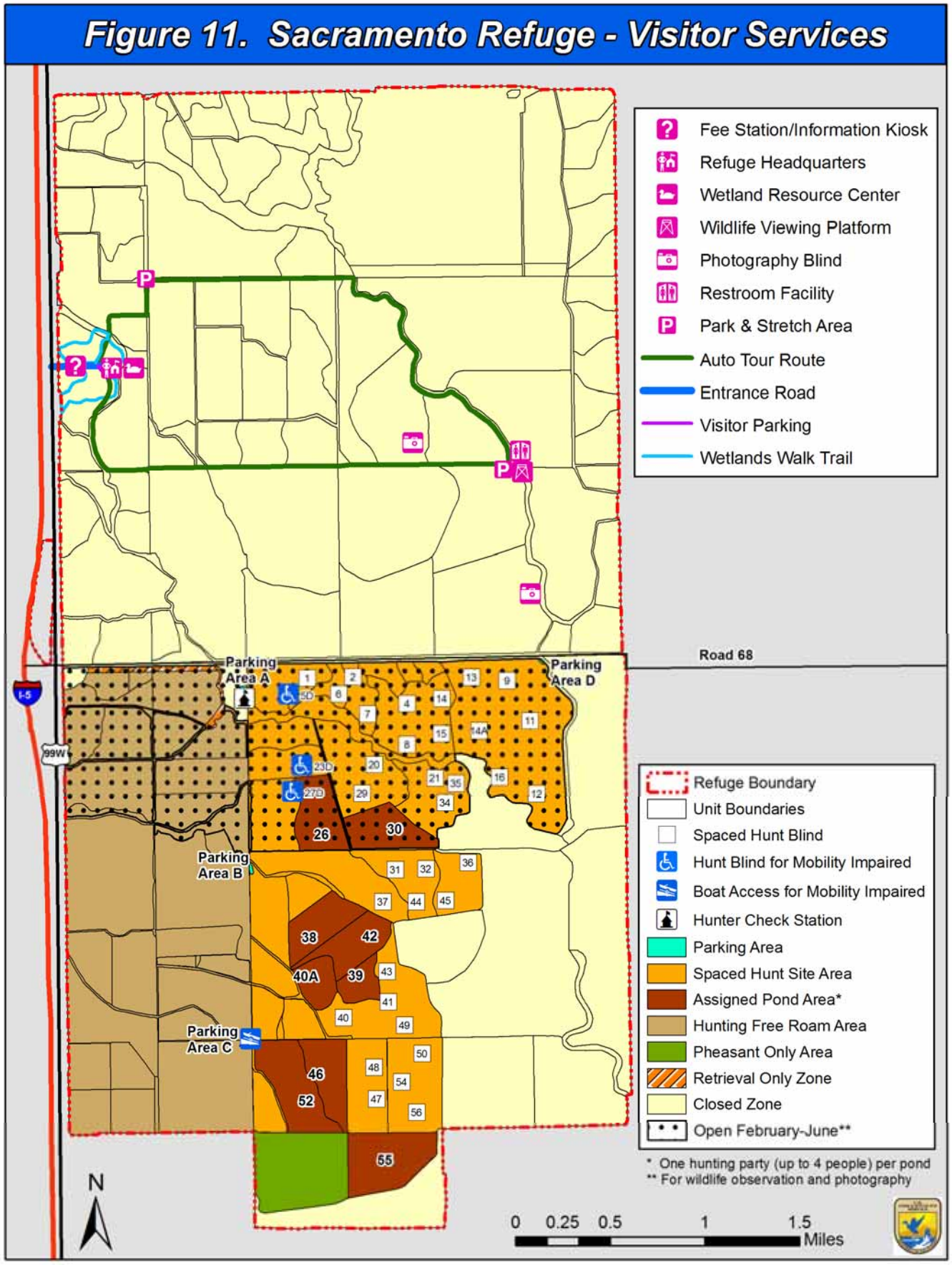


Figure 11. Sacramento Refuge - Visitor Services
Fee Station/Information Kiosk
Refuge Headquarters
Wetland Resource Center
Wildlife Viewing Platform
Photography Blind
Restroom Facility
Park & Stretch Area
Auto Tour Route
Entrance Road
Visitor Parking
Wetlands Walk Trail
Road 68
Parking Area A
Parking Area B
Parking Area C
Parking Area D
I-5
99W
Refuge Boundary
Unit Boundaries
Spaced Hunt Blind
Hunt Blind for Mobility Impaired
Boat Access for Mobility Impaired
Hunter Check Station
Parking Area
Spaced Hunt Site Area
Assigned Pond Area*
Hunting Free Roam Area
Pheasant Only Area
Retrieval Only Zone
Closed Zone
Open February-June**
* One hunting party (up to 4 people) per pond
** For wildlife observation and photography
N
0 0.25 0.5 1 1.5
Miles

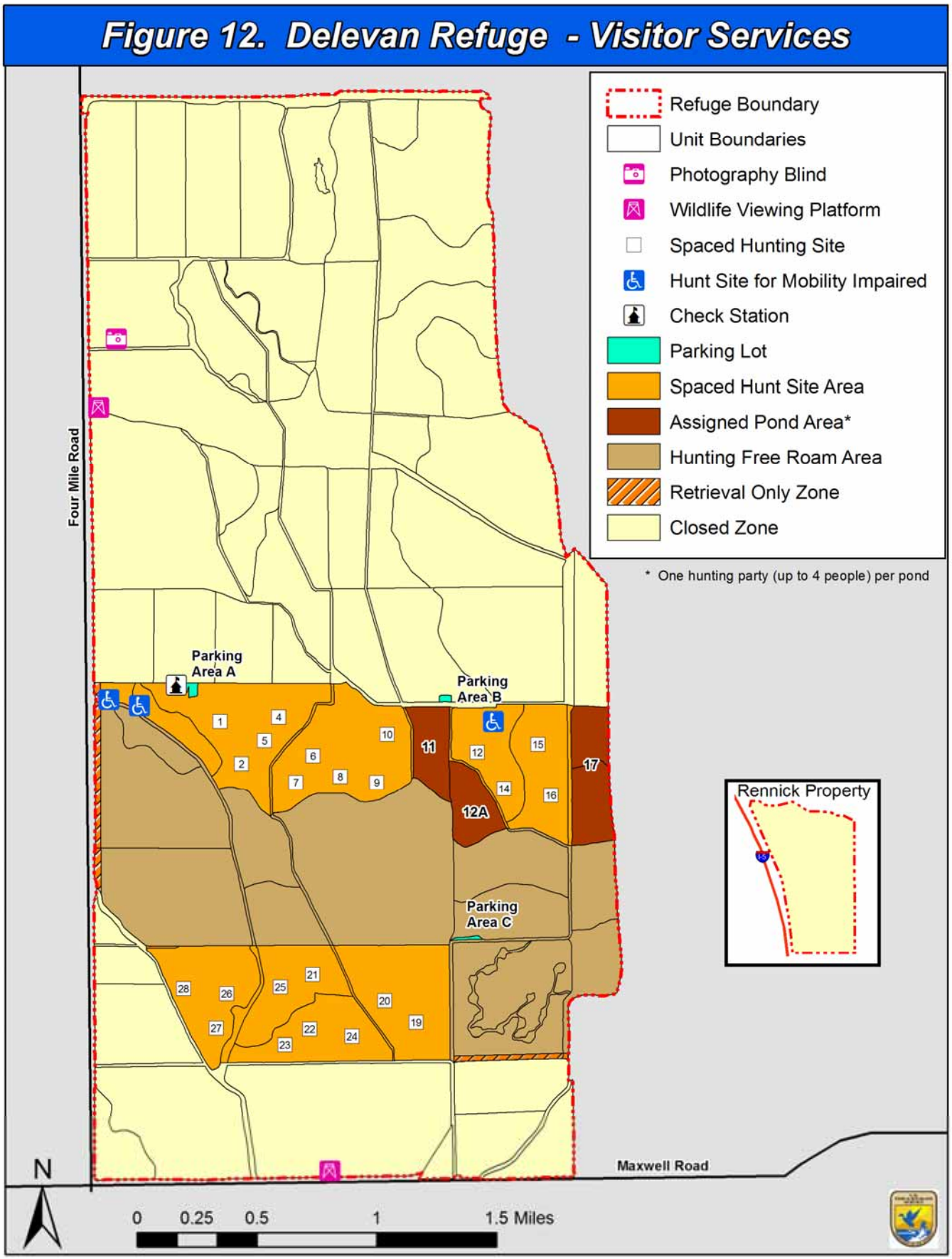


Figure 12. Delevan Refuge - Visitor Services
Refuge Boundary
Unit Boundaries
Photography Blind
Wildlife Viewing Platform
Spaced Hunting Site
Hunt Site for Mobility Impaired
Check Station
Parking Lot
Spaced Hunt Site Area
Assigned Pond Area*
Hunting Free Roam Area
Retrieval Only Zone
Closed Zone
* One hunting party (up to 4 people) per pond
Four Mile Road
Parking Area A
Parking Area B
Parking Area C
1
2
4
5
6
7
8
9
10
11
12
12A
14
15
16
17
19
20
21
22
23
24
25
26
27
28
Rennick Property
Maxwell Road
N
0
0.25
0.5
1
1.5 Miles

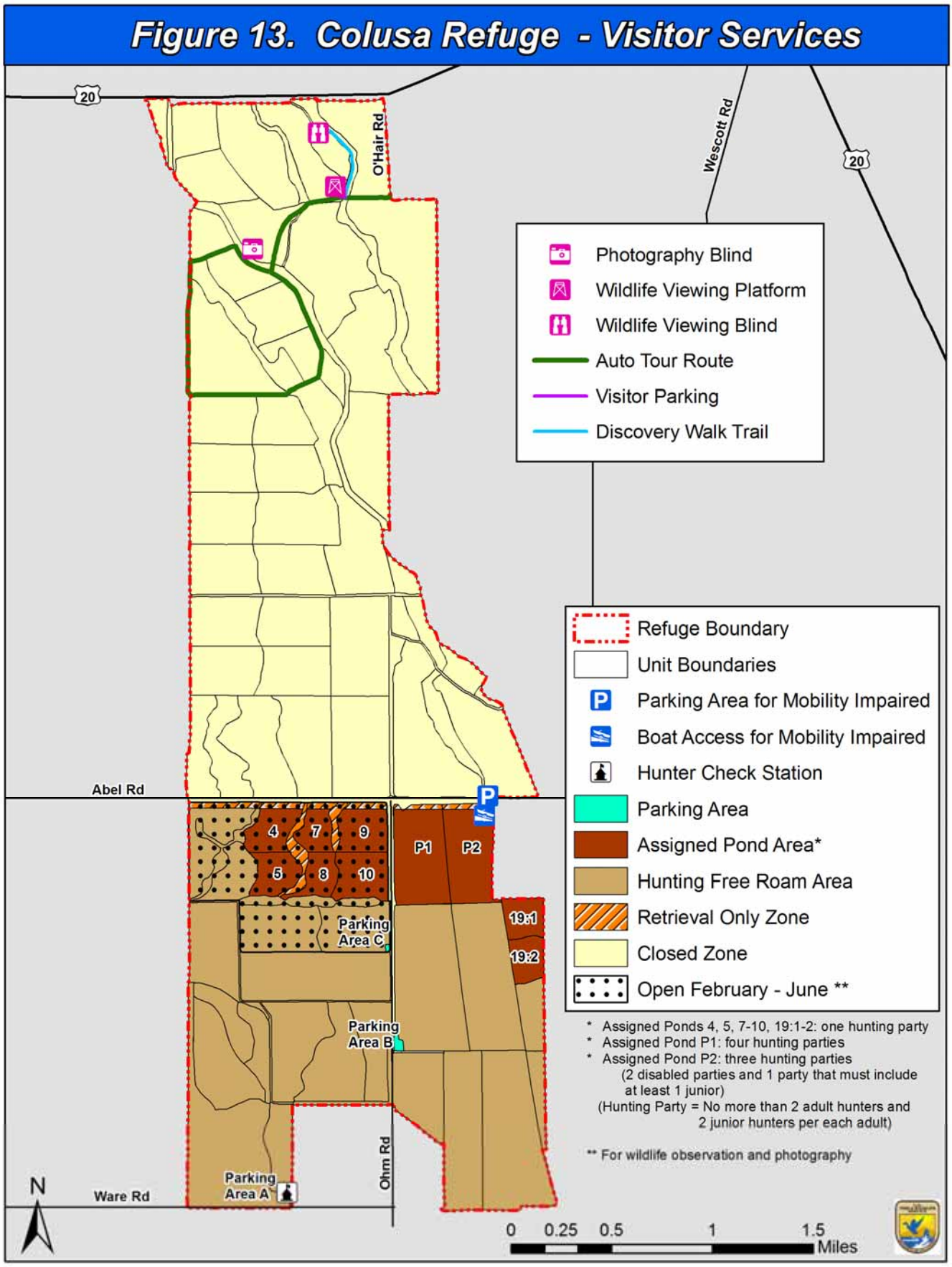


Figure 13. Colusa Refuge - Visitor Services
20
O'Hair Rd
Wescott Rd
20
Photography Blind
Wildlife Viewing Platform
Wildlife Viewing Blind
Auto Tour Route
Visitor Parking
Discovery Walk Trail
Refuge Boundary
Unit Boundaries
Parking Area for Mobility Impaired
Boat Access for Mobility Impaired
Hunter Check Station
Parking Area
Assigned Pond Area*
Hunting Free Roam Area
Retrieval Only Zone
Closed Zone
Open February - June **
Abel Rd
4
7
9
5
8
10
P1
P2
19:1
19:2
Parking Area C
Parking Area B
Parking Area A
Ohm Rd
Ware Rd
N
* Assigned Ponds 4, 5, 7-10, 19:1-2: one hunting party
* Assigned Pond P1: four hunting parties
* Assigned Pond P2: three hunting parties
(2 disabled parties and 1 party that must include at least 1 junior)
(Hunting Party = No more than 2 adult hunters and 2 junior hunters per each adult)
** For wildlife observation and photography
0 0.25 0.5 1 1.5
Miles

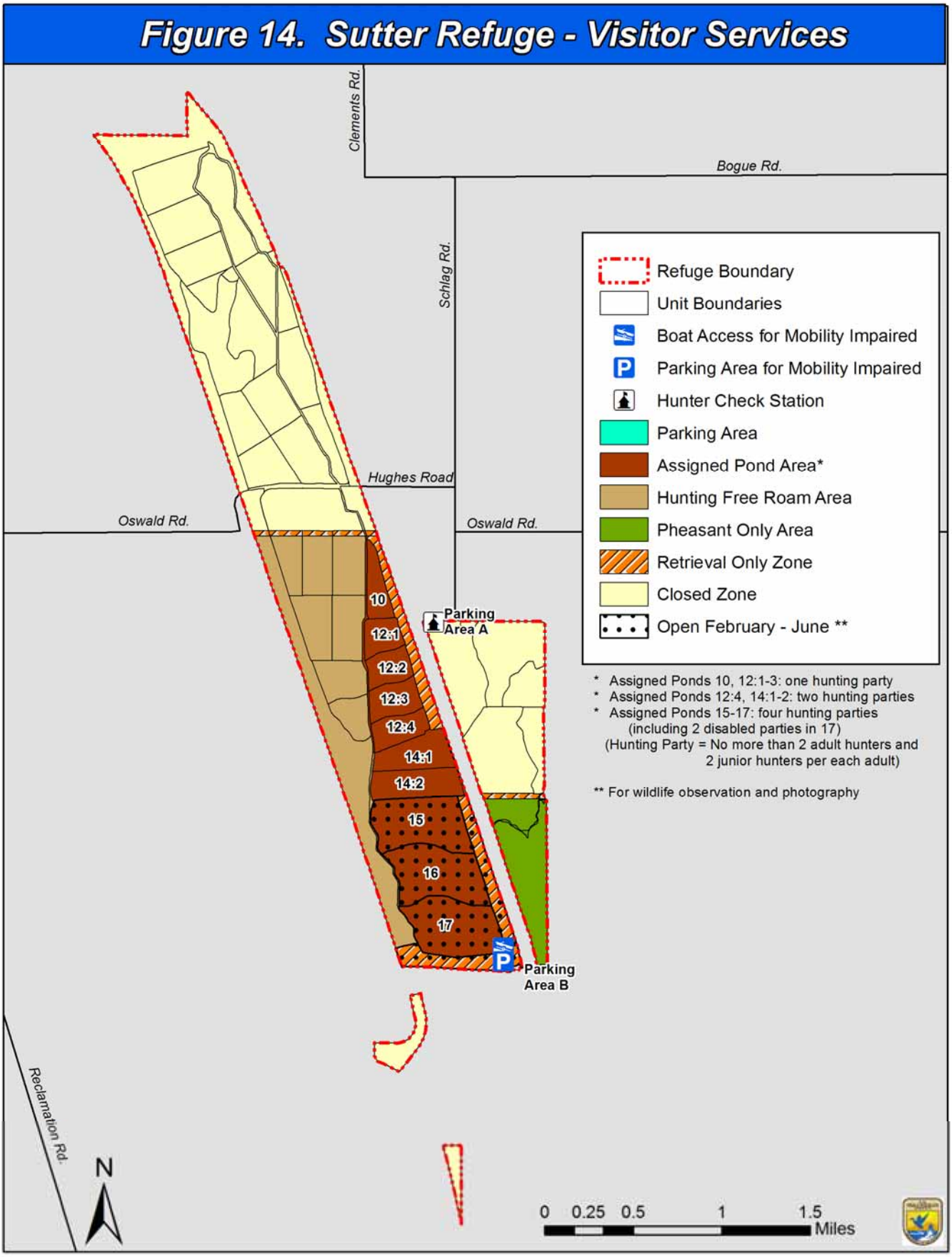


Figure 14. Sutter Refuge - Visitor Services
Clements Rd.
Bogue Rd.
Schlag Rd.
Hughes Road
Oswald Rd.
Oswald Rd.
Reclamation Rd.
Parking Area A
Parking Area B
10
12:1
12:2
12:3
12:4
14:1
14:2
15
16
17
Refuge Boundary
Unit Boundaries
Boat Access for Mobility Impaired
Parking Area for Mobility Impaired
Hunter Check Station
Parking Area
Assigned Pond Area*
Hunting Free Roam Area
Pheasant Only Area
Retrieval Only Zone
Closed Zone
Open February - June **
* Assigned Ponds 10, 12:1-3: one hunting party
* Assigned Ponds 12:4, 14:1-2: two hunting parties
* Assigned Ponds 15-17: four hunting parties (including 2 disabled parties in 17)
(Hunting Party = No more than 2 adult hunters and 2 junior hunters per each adult)
** For wildlife observation and photography
N
0 0.25 0.5 1 1.5 Miles

Hunting Strategies:

3.1.1. Implement the Hunt Plan for the Refuges.

3.1.2. Coordinate hunt program operations with CDFG including the annual pre and post hunting meetings.

3.1.3. Add hunt program changes to CDFG regulations and 50 CFR annually.

3.1.4. Provide the Complex's hunting brochure at the hunter check station, interpretive kiosks, and visitor center.

3.1.5. Disseminate hunting information packet at the Refuge Complex visitor center.

3.1.6. Provide and update hunting information on the Complex's 24-hour telephone information line and on the website.

3.1.7. Continue to coordinate the Junior and Youth Waterfowl Hunts on Sacramento, Delevan, and Colusa Refuges with California Waterfowl Association and CDFG.

3.1.8. Monitor hunting visits and bird harvest every hunt day.

3.1.9. Work with the Refuge Complex's Hunting Program Working Group to develop and improve the Refuges' hunting program, including access and facilities for hunters with disabilities.

3.1.10. Work cooperatively with CDFG wardens to enforce State Fish and Game hunting laws and Refuge-specific regulations to provide a quality experience for all visitors.

3.1.11. Maintain hunter check stations and kiosks to effectively process hunters and provide hunter-related information.

Waterfowl hunting on Colusa Refuge
Photo by Mike Peters

3.1.12. Convert a portion of the free roam area to assigned ponds at Sutter and Colusa Refuges and convert some spaced blinds to assigned ponds at Sacramento Refuge.

3.1.13. Consider allowing limited spring turkey hunting opportunities on Sacramento, Delevan, and Colusa Refuges based on sufficient numbers present on the Refuges, habitat conditions, and the development of a turkey hunt management plan, as well as the appropriate National Environmental Policy Act compliance.

3.1.14. Hire one full-time clerk position to implement the hunting program and support other Refuge programs.

3.2. Wildlife Observation Objective

Provide quality opportunities for 100,000 wildlife viewing annual visits on 8,575 acres by 2023.

Rationale: Wildlife observation is identified in the Improvement Act as a priority public use that can be allowed when compatible with other Refuge purposes. As a result, the Refuges encourage first-hand opportunities to observe wildlife in their habitats. This activity will be managed to ensure that people have opportunities to observe wildlife in ways that minimize wildlife disturbance and damage to the Refuges' habitats. Wildlife viewing will be managed to foster a connection between visitors and natural resources. The Visitor Services Plan (Appendix D) was developed to provide guidance for the Refuges' public use program. The wildlife observation program will be managed in accordance with Service Manual 605 FW 4, Wildlife Observation.

Wildlife observation
Photo by Jackie Ferrier

Wildlife Observation Strategies:

3.2.1. Maintain and enhance auto tour routes on Sacramento and Colusa Refuges to provide viewing opportunities of wildlife and their habitats.

3.2.2. Expand the hours on all Refuges to one hour before sunrise to one hour after sunset.

3.2.3. Maintain the wildlife viewing facilities on Sacramento, Delevan, and Colusa Refuges.

3.2.4. Upgrade walking trails on Sacramento and Colusa Refuges to provide for universal access.

3.2.5. Construct a walking trail on Sutter Refuge and provide

guided tours from April-June.

3.2.6. Continue to plan and integrate universal access, facilities and programs to provide and enhance a quality wildlife observation program, including replacement of the wildlife observation blind at Colusa Refuge with an accessible blind and boardwalk.

3.2.7. Open selected portions of the hunt area (2,275 acres) and modify parking areas to provide wildlife observation from February through June (post waterfowl season) on Sacramento, Colusa, and Sutter Refuges.

3.2.8. Add wildlife viewing platforms along Maxwell Road and Four Mile Road on Delevan Refuge.

3.2.9. Install a remote camera on an eagle nest or a view of the Butte Sink WMA to facilitate viewing via the Complex's website and the Refuge Headquarters.

3.2.10. Increase the Refuge Day and Annual Pass fees.

3.2.11. Hire a full-time tractor operator and maintenance worker to implement the wildlife observation and support other Refuge programs.

3.3. Wildlife Photography Objective

Provide quality opportunities for 80 photography blind visits and 10,000 wildlife photography annual visits on 8,758 acres by 2023.

Rationale: Wildlife photography is identified in the Improvement Act as a priority public use that can be allowed when compatible with other Refuge purposes. As a result, the Refuges encourage first-hand opportunities to observe and photograph wildlife in their habitats. This activity will be managed to ensure that people have opportunities to photograph wildlife in ways that minimize wildlife disturbance and damage to the Refuges' habitats. Wildlife photography will be managed to foster a connection between visitors and natural resources. The Visitor Services Plan (Appendix D) was developed to provide guidance for the Refuges' public use program. The wildlife photography program will be managed in accordance with Service Manual 605 FW 5, Wildlife Photography.

Wildlife Photography Strategies:

3.3.1. Maintain and enhance auto tour routes on Sacramento and Colusa Refuges to provide photographic opportunities from a vehicle.

3.3.2. Maintain two wildlife photography blinds on Sacramento Refuge and one wildlife photography blind on Colusa Refuge.

3.3.3. Construct and maintain a universally accessible photography blind on Delevan Refuge. Replace one of the Sacramento Refuge wildlife photography blinds with a universally accessible blind.

3.3.4. Open selected portions of the hunt area (2,275 acres) and modify parking areas to provide wildlife photography from February through June (post waterfowl season) on Sacramento, Colusa, and Sutter Refuges.

3.3.5. Update photographer guidelines, maps, and photography blind reports annually.

3.3.6. Evaluate photography blind reports and implement changes annually.

3.3.7. Maintain the Complex's website to provide information about current photographer guidelines and facilities.

3.3.8. Offer photography workshops and guided field trips on Sacramento Refuge utilizing the Wetlands Resource Center.

3.4. Environmental Education Objective

Develop an environmental education program by 2023 to serve 5,000 students annually. Develop an environmental education program that promotes in-depth studies of the ecological principles that are associated with wetland and riparian ecosystems and the Refuges' natural, cultural, and historical resources. The education activities will be designed to develop awareness and understanding for refuge resources and management activities.

Marsh Madness at Sacramento Refuge
USFWS photo

Rationale: Environmental education is identified in the Improvement Act as a priority public use that can be allowed when compatible with other Refuge purposes. The Refuges encourage environmental education as a process of building knowledge in students. The refuge staff will work with schools (K-12) to integrate environmental concepts and concerns into structured educational activities. These Refuge-lead or educator-conducted activities are intended to actively involve students or others in first-hand activities that promote

discovery and fact-finding, develop problem-solving skills, and lead to personal involvement and action. Refuge staff will promote environmental education that: is aligned to the current Federal, State and local standards; is curriculum-based that meets the goals of school districts adopted instructional standards; and provides interdisciplinary opportunities that link the natural world with all subject areas. The Visitor Services Plan (Appendix D) was developed to provide guidance for the Refuges' public use program. The environmental education program will be managed in accordance with Service Manual 605 FW 6 Environmental Education. This objective also helps to achieve Statewide Conservation Action J in the California Wildlife Action Plan (CDFG 2005c).

Environmental Education Strategies:

3.4.1. Construct and operate a Wetlands Resource Center at Sacramento Refuge.

3.4.2. Schedule and plan 100 school group field trips annually utilizing the Wetlands Resource Center at Sacramento Refuge and the visitor facilities at Colusa Refuge.

3.4.3. Offer the Discovery Pack containing environmental education activities and on-site information for use on walking trails on Sacramento and Colusa Refuges.

3.4.4. Annually assist schools who wish to implement their in-depth study of wetlands and riparian habitats on Sacramento Refuge utilizing the Wetlands Resource Center.

3.4.5. Facilitate after school programs involving activities such as habitat restoration, wetland analysis, and student mentor workshops.

3.4.6. Develop a partnership with the Girl Scouts: Linking Girls to the Land to assist habitat restoration projects.

3.4.7. Facilitate two annual resource-training workshops (e.g. Project Wild or Project Wet) about the Refuges' environmental education program for educators.

3.4.8. Annually disseminate current environmental education program guidelines and activities offered to teachers.

3.4.9. Maintain the Complex's website to promote current educational opportunities, provide reservation form, and update guidelines.

3.4.10. Update and provide the Environmental Education Guide brochure.

3.4.11. Utilize interpretive specialists, interns, and volunteers to facilitate the environmental education program.

3.4.12. Hire one full-time interpretive specialist to implement environmental education activities and the visitor services program.

3.4.13. Hire one full-time custodian/maintenance worker to maintain visitor service facilities.

3.5. Interpretation Objective

Refuge staff will develop an interpretive program to provide 20,000 annual visits. The program will promote public awareness and support of the Refuges' resources and management activities by 2023.

Rationale: Interpretation is identified in the Improvement Act as a priority public use that can be allowed when compatible with other Refuge purposes. As a result, the Refuges encourage interpretation as both an educational and recreational opportunity that is aimed at revealing relationships, examining systems, and exploring how the natural world and human activities are interconnected. Participants of all ages can voluntarily engage in stimulating and enjoyable activities as they learn about the issues confronting fish and wildlife resource management on the Refuges. First-hand experiences with the environment will be emphasized, although presentations, audiovisual media, and exhibits will be necessary components of the Refuges' interpretive program. The Visitor Services Plan (Appendix D) was developed to provide guidance for the Refuges' public use program. The interpretive program will be managed in accordance with Service Manual 605 FW 7, Interpretation.

Effective outreach is an important component of the interpretive program. The Refuges will provide two-way communication between the Refuges and the public to establish a mutual understanding and promote involvement with the goal of improving joint stewardship of our natural resources. Outreach will be designed to identify and understand the issues and target audiences, craft messages, select the most effective delivery techniques, and evaluate effectiveness. Refuge outreach will follow the guidance of the National Outreach Strategy: A Master Plan for Communicating in the U.S. Fish and Wildlife Service (USFWS 1997).

In 2007, the Service declared that "connecting people with nature" is among the agencies highest national priorities (USFWS 2008). A connection with nature, whether it's hiking, fishing, camping, hunting, or simply playing outside, helps children develop positive attitudes and behaviors towards the environment. Positive interactions with the environment can lead to a life-long interest in enjoying and preserving nature. People's interest in nature is crucial to the Service

mission of conserving, protecting, and enhancing fish, wildlife, plants, and their habitats.

Interpretation Strategies:

3.5.1. Use the Complex's visitor center to provide presentations and exhibits.

3.5.2. Maintain interpretive kiosks, walking trails, auto tour routes, the visitor center, and Wetlands Resource Center for use by refuge visitors.

3.5.3. Lead at least 20 tour groups on the Refuges annually.

3.5.4. Develop "Sense of Wonder Zones" or naturalized play areas for family-oriented activities on the Sacramento and Colusa Refuges where people of all ages can reconnect with nature.

3.5.5. Create interpretive geocaching opportunities on the Sacramento and Colusa Refuges where people of all ages can increase their awareness of fish and wildlife resources and outdoor activities that the Refuges provide.

3.5.6. Continue to participate in or provide information to local annual events (e.g. International Migratory Bird Day, National Wildlife Refuge Week, Snow Goose Festival, Pacific Flyway Decoy Association Wildlife Art Festival, California State Fair, International Sportsman's Expo, and Return of the Salmon Festival).

3.5.7. Participate in fire prevention education and outreach about the role of fire and its management uses.

3.5.8. Write news releases for local and State newspapers and articles for magazines. Conduct television and radio interviews upon request.

3.5.9. Maintain the Complex's website.

3.5.10. Maintain the Sacramento Refuge radio station (FM 93.1).

3.5.11. Provide interpretive brochures at kiosks and in the visitor center.

3.5.12. Maintain and upgrade the Discovery Room displays, videos, and activities.

3.5.13. Manage and stock the bookstore to provide relevant books and miscellaneous items that relate to the Complex.

3.5.14. Continue to coordinate and facilitate the California Junior

Duck Stamp Contest and judging.

3.5.15. Continue to host and facilitate California Waterfowl Association's (CWA) Marsh Madness school events.

3.5.16. Utilize interpretive specialists, interns, and volunteers to coordinate annual events on and off Refuge, manage the bookstore, and coordinate the California Junior Duck Stamp Program.

3.5.17. Utilize interns to assist with Refuge programs (e.g. managing the visitor center on weekends, facilitating school groups).

Junior Duck Stamp Display at Snow Goose Festival
Photo by Jackie Ferrier

3.6. Volunteer Objective

Increase the number of volunteers to 120 in order to support a variety of Refuge programs by 2023.

Rationale: The National Wildlife Refuge System Volunteer and Partnership Enhancement Act of 1998 (P.L. 105-242) strengthens the Refuge System's role in developing relationships with volunteers. Volunteers possess knowledge, skills, and abilities that can enhance the scope of refuge operations. Volunteers enrich refuge staff with their gift of time, skills, and energy. Refuge staff will initiate, support, and nurture relationships with volunteers so that they may continue to be an integral part of Refuge programs and management. The volunteer program will be managed in accordance with the Fish and Wildlife Service Manual, Part 150, Chapters 1-3, "Volunteer Services Program", and Part 240 Chapter 9 "Occupational Safety and Health, Volunteer and Youth Program".

Currently the Complex volunteer program consists of 69 individuals who assist with wildlife-dependent recreation, maintenance, wildlife

and habitat management, environmental education, and cultural resource programs.

Volunteer Strategies:

3.6.1. Utilize interpretative specialists and interns to coordinate the volunteer program.

3.6.2. Recruit interns through the California Waterfowl Association, California State University Chico (CSU/Chico) internship program, and other universities.

3.6.3. Recruit a variety of community groups and individuals (e.g. CSU/Chico, Butte College, Boy Scouts, Girl Scouts, Altacal Audubon Society).

3.6.4. Host an annual volunteer recognition dinner.

3.6.5. Facilitate volunteer training workshops.

3.6.6. Host an annual work day (Brush Up Day) to clean up Refuges' hunt areas.

3.6.7. Utilize the Girl Scout Council to recruit volunteers.

3.6.8. Provide Service volunteer uniforms for all volunteers to wear when greeting the public or at special events.

American wigeon
Photo by Steve Emmons

4. Partnerships Goal

Promote partnerships to preserve, restore, and enhance a diverse, healthy, and productive ecosystem in which the Refuges play a key role.

4.1. Partnership Objective

Maintain and enhance at least 25 partnerships among Federal, State, local agencies, organizations, schools, corporations, and private landowners to promote the understanding and conservation of the Refuges' resources, activities, and management by 2023.

Rationale: The Service recognizes that strong citizen support benefits the Refuge System. These benefits include the involvement and insight of citizen groups in the Refuges' resource and management issues and decisions, a process that helps managers gain an understanding of public concerns. Partners support Refuge activities and programs, raise funds for projects, are advocates on behalf of wildlife and the Refuge System, and provide support on important wildlife and natural resource issues. In "Fulfilling the Promise" (USFWS 1999c), the Service identified the need to forge new and non-traditional alliances and strengthen existing partnerships with States, Tribes, non-profit organizations and academia to broaden citizen and community understanding and support for the National Wildlife Refuge System. This objective also helps to achieve Central Valley and Bay-Delta Region Conservation Actions B and L in the California Wildlife Action Plan (CDFG 2005c).

A variety of people including, but not limited to, scientists, farmers, birders, hunters, photographers, and students have a great deal of interest in the Complex's management, fish and wildlife species, and habitats. New partnerships will be formed as opportunities, funding, and staff are available.

Partnership Strategies:

4.1.1. Maintain good relations and open communication with partners.

4.1.2. Actively look for partnering opportunities with local and regional conservation groups, academic institutions, organizations, and other local, State and Federal agencies.

4.1.3. Pursue opportunities to cost-share mutually beneficial projects with other organizations.

4.1.4. Expand opportunities with local Chambers of Commerce to participate in local events and improve dissemination of public recreation literature about the Refuges.

4.1.5. Stay actively involved in Federal, State, and local planning

processes to protect the Refuges' resources and foster cooperative management of those resources.

4.1.6. Work closely with Bureau of Reclamation and local irrigation district personnel on water delivery issues.

4.1.7. Continue to participate in the Sacramento Valley Water Quality Coalition.

4.1.8. Continue partnership with Altacal Audubon Society to operate the bookstore at Sacramento Refuge.

4.1.9. Maintain active participation with the Central Valley Joint Venture.

4.1.10. Maintain cooperative agreement with U.S. Geological Survey to conduct management-oriented research and monitoring efforts.

4.1.11. Continue partnerships with California Waterfowl Association, Ducks Unlimited, and other conservation non-governmental organizations.

4.2. Cooperation with Adjacent Landowners Objective

By 2023, create 10 opportunities for new and maintain existing partnerships with private landowners to promote cooperation and address mutual concerns.

Rationale: It is important to communicate with our neighbors to help identify any issues at an early stage and attempt to resolve any conflicts that may exist.

Private Landowner Cooperation Strategies:

4.2.1. Maintain contact with adjacent neighbors to discuss mutual concerns and opportunities.

4.2.2. Implement improvements and operational revisions to resolve issues with adjacent landowners that are compatible with the mission of the Service and purpose of the Refuges, as well as consistent with the funding available to the Refuges.

4.2.3. Design habitat restoration projects to address considerations of adjoining landowners, including but not limited to:

- Provision of access controls and access for emergency and utility services.
- Consideration of appropriate fire access and breaks.

- Consideration of appropriate buffers where new planting directly adjoins agricultural crops.

- Use of natural predation control strategies.

4.2.4. Continue to consult with adjoining landowners as part of the development of plans for proposed restoration projects and other physical changes to the Refuges.

4.2.5. Commission field surveys as needed to identify specific property boundaries where uncertainty has contributed to substantive violations of Refuge regulations.

4.2.6. Annually host a habitat management workshop for private landowners.

5. Resource Protection Goal

Adequately protect and maintain all natural and cultural resources, staff and visitors, equipment, facilities, and other property on the Refuges.

5.1. Law Enforcement Objective

Provide a safe environment for visitors, protect the Refuges' resources, and ensure compliance with regulations through effective law enforcement on each Refuge by 2008.

Rationale: An increasing number of Refuge facilities and visitors necessitate an adequate level of safety and security through an enhanced law enforcement presence. Illegal activities, such as drug cultivation, poaching, vandalism, and vehicle stripping, are present on Refuge lands where there are public activities. Strict law enforcement and the support of partners are necessary to provide a safe environment for visitors and staff. In addition, a common belief among neighboring landowners is that public ownership, easements, or access could result in increased vandalism and theft of agricultural equipment, poaching, and disregard of private property rights. A well-planned and coordinated program will be necessary to successfully address these concerns. This objective also helps to achieve Central Valley and Bay-Delta Region Conservation Action Q in the California Wildlife Action Plan (CDFG 2005c).

Law Enforcement Strategies

5.1.1. Develop Memorandum of Understandings (MOUs) with various law enforcement agencies to improve coordination, improve safety, and coordinate efforts in areas of special concern.

5.1.2. Provide public education and signage as part of law enforcement programs and provide a sufficient level of law enforcement from various agencies to address these issues.

5.1.3. Employ three full-time park rangers (refuge law enforcement officers), one full-time supervisory law enforcement officer, and supplement their duty schedule with dual-function officers.

5.1.4. Maintain a daily law enforcement presence to ensure that violations are deterred or successfully detected, investigated, and the violators are apprehended, charged, and prosecuted.

5.1.5. Have refuge officers work closely with CDFG game wardens and deputy sheriffs from Glenn, Colusa, and Sutter counties.

5.1.6. Develop a Law Enforcement Plan for the Complex.

5.1.7. Annually maintain boundary, closed area, and other public use signs.

5.2. Safety Objective

By 2008, provide Refuge facilities and lands that are safe for public use and management activities through annual inspections and routine maintenance.

Rationale: Visitor and staff safety is a high priority for the Refuges. It is extremely important to have comprehensive safety strategies. The Refuges are committed to training staff in the most current safety standards and practices, maintaining facilities, coordinating with law enforcement partners, and providing an effective monitoring program to provide the safest environment possible.

Northern harrier
Photo by Steve Emmons

Safety Strategies:

5.2.1. Administer and monitor required permits, licenses, and inspections on a repetitive basis under the Federal Facility Compliance Act and Service policy.

5.2.2. Promptly replace, upgrade, or temporarily close any facility that comprises a public safety hazard.

5.2.3. Minimize injuries to staff and visitors through preventive measures and be prepared to respond to injuries if they occur.

5.2.4. Ensure that safety procedures, designated personnel, and equipment and supplies (e.g., first aid kits and fire extinguishers) are in place and kept current.

5.2.5. Conduct monthly staff safety meetings covering pertinent topics, quarterly safety committee meetings, and annual safety inspections to ensure that Refuge facilities and lands are safe for public and staff use.

5.2.6. Train and refresh staff in CPR and basic first aid.

5.2.7. Maintain existing access roads and parking areas by grading, mowing, and replacing culverts, as needed, for public vehicle access, law enforcement, and habitat management activities.

5.2.8. Maintain secondary roads and pathways for public pedestrian traffic by grading, mowing and replacing culverts, as needed.

5.2.9. Help protect refuge visitors, neighbors, and employees through fire prevention, hazard reduction, and fire trespass programs.

5.2.10. Maintain a current knowledge and status of local wildlife diseases that are potentially transmitted to humans, and manage visitation accordingly. Provide timely information to the public.

5.2.11. Continue to prohibit the use or possession of alcoholic beverages while hunting (50 CFR 32.2j). In addition, prohibit the consumption or possession of an open container of alcohol within public areas on the Refuges.

5.3. Facility Maintenance Objective

By 2023, perform and document preventive and corrective maintenance on 100 percent of the buildings, structures, and access routes, including facilities with historic significance.

Rationale: Maintenance of buildings, structures, and access routes is critical to meeting Refuge administrative needs and resource goals.

Facility Maintenance Strategies:

5.3.1. Maintain existing offices, shops, and check stations.

5.3.2. Maintain historic buildings and structures.

5.3.3. Maintain roads, levees, fences, gates, water conveyance system, and other Real Property to Service standards.

5.3.4. Hire a facility management coordinator to operate and maintain the Service Asset Maintenance Management System and Real Property databases.

Black-tailed jackrabbit
Photo by Steve Emmons

Chapter 5. Management Plan Implementation

1. Implementation

The CCP will serve as the primary management reference document for Refuge planning, operations, and management for the next 15 years or until it is formally revised or amended within that period. The Service will implement the final CCP with assistance from existing and new partner agencies and organizations and from the public. The timing and achievement of the management strategies proposed in this document are contingent upon a variety of factors, including:

- Funding & Staffing
- Completion of Step-Down Plans
- Compatibility Determinations
- Compliance Requirements
- Adaptive Management
- Monitoring

Each of these factors is briefly discussed as it applies to the CCP.

CCPs provide long-term guidance for management decisions and set forth goals, objectives, and strategies needed to accomplish refuge purposes and identify the Service's best estimate of future needs. These plans detail program planning levels that are sometimes substantially above current budget allocations and, as such, are primarily for Service strategic planning and program prioritization purposes. Accordingly, the plans do not constitute a commitment for staffing increases, operational and maintenance increases, or funding for future land acquisition.

2. Funding & Staffing

Resources are required to adequately operate any national wildlife refuge including initial capital outlay for equipment, facilities, labor and other expenses as well as recurring expenses (Table 21). The estimated initial capital outlay to implement the strategies described in this CCP is approximately $19 million. Not all of these capital expenditures would occur in the same year as many of these expenses would be most likely implemented over the next fifteen years if approval and funding is provided by Congress. The detailed descriptions of the objectives and their associated implementation strategies serve as a guide to the ideal time frame in which to implement capital expenditures. The largest costs for initial outlays are for visitor services and habitat restoration.

Table 21. Estimated Initial Capital Outlay to Fully Implement the CCP.

Expenditure [Related Objective(s)]	Unit Cost	Unit	Quantity	Total Cost
Construct Wetland Resource Center (Sac) [Objectives 3.4, 3.5]	$5,984,000	ea	1.0	$5,984,000
Obtain equipment and supplies for Wetland Resource Center (Sac) [Objectives 3.4, 3.5]	$184,800	ea	1.0	$184,800
Improve entrance road and visitor parking area including railroad crossing device (Sac) [Objective 5.2]	$540,000	ea	1.0	$540,000
Construct accessible restroom (Sac) [Objectives 3.2, 3.3, 3.4, 3.5]	$227,000	ea	1.0	$227,000
Replace deteriorated domestic water well and water lines at headquarters (Sac) [Objectives 5.2, 5.3]	$190,000	ea	1.0	$190,000
Repair visitor entrance road and parking areas (Sac) [Objectives 3.2, 3.4, 3.5, 5.3]	$60,800	ea	1.0	$60,800
Improve Maxwell Road Parking area including viewing platform (Del) [Objectives 3.2, 3.5]	$102,200	ea	1.0	$102,200
Obtain Wayside Exhibit materials for viewing platform (Del) [Objectives 3.2, 3.5]	$94,600	ea	1.0	$94,600
Construct parking area and viewing platform along 4-Mile Road (Del) [Objectives 3.2, 3.3, 3.5]	$80,000	ea	1.0	$80,000
Construct universally accessible photography blind including boardwalk (Sac) [Objective 3.3]	$33,100	ea	1.0	$33,100
Construct universally accessible photography blind including boardwalk (Del) [Objective 3.3]	$18,000	ea	1.0	$18,000
Modifications in hunt areas for spring-summer use (e.g. signs, additional kiosks, parking lot modifications, etc.) (Sac, Col and Sut) [Objectives 3.2, 3.3]	$10,000	ea	3.0	$30,000
Renovate existing trails for universal access (Sac) [Objectives 3.2, 3.3, 3.4, 3.5]	$116,000	ea	1.0	$116,000
Renovate existing trail for universal access (Col) [Objectives 3.2, 3.3]	$75,000	ea	1.0	$75,000
Replace wildlife observation blind with an accessible blind and board walk (Col) [Objectives 3.2, 3.3]	$75,000	ea	1.0	$75,000
Install electric line for hunter check station (Del) [Objectives 3.1, 5.2]	$172,000	ea	1.0	$172,000
Replace hunter access bridges with culverts (Sac and Del) [Objectives 3.1, 5.2, 5.3]	$10,000	ea	2.0	$20,000

Restore Tract 26 to grassland / wetland mix (Col) [Objective 1.2]	$50,000	ea	1.0	$50,000
Replace maintenance shop (Sac) [Objectives 5.2, 5.3]	$1,400,000	ea	1.0	$1,400,000
Construct fire cache and vehicle storage building (Sac) [Objectives 5.2, 5.3]	$470,000	ea	1.0	$470,000
Widen and improve 26.2 delivery canal (Sac) [Objectives 1.1, 5.3]	$2,511,000	ea	1.0	$2,511,000
Replace deteriorated water control structures (all) [Objectives 1.1, 5.3]	$1,501,000	ea	1.0	$1,501,000
Install sprinkler fire-protection and burglar alarm systems in headquarter office (Sac) [Objective 5.2]	$86,000	ea	1.0	$86,000
Renovate Necropsy Building (Sac) [Objective 5.3]	$160,000	ea	1.0	$160,000
Construct equipment storage buildings (Col and Sut) [Objectives 1.1, 3.1, 5.3]	$86,000	ea	2.0	$172,000
Repair service roads (Sac) [Objectives 1.1, 5.3]	$18,000	mi	2.0	$36,000
Repair eroded levees in wetland units (Del) [Objectives 1.1, 5.3]	$26,400	mi	5.0	$132,000
Purchase disking tractor (Complex) [Objectives 1.1, 1.3, 1.13, 3.1, 3.2, 5.3]	$115,000	ea	1.0	$115,000
Purchase pull scraper (Sut) [1.1, 5.3]	$33,000	ea	1.0	$33,000
Replace existing heavy equipment backlog (Complex) [Objectives 1.1, 3.1, 5.3]	$4,268,000	ea	1.0	$4,268,000
Total				**$18,936,500**

Annual contracts or cooperative agreements will be needed to provide specialized services beyond the core Refuge functions for which staff are required. The recurring CCP implementation total approximately $3.4 million (Table 22).

Figures 15 and 16 show the Complex's organization charts with both current and new positions identified. If all positions indicated in Table 22 and Figures 15 and 16 are filled, the Refuges would be able to carry out all aspects of this plan to a reasonable standard. If some positions are not filled, all aspects of the Plan would not be completed or those projects may be done over a longer period of time.

Table 22. Estimated Annual Cost to Fully Implement the CCP[1].

Expenditure	Unit Cost[2]	Unit	Quantity	Total Cost	Phase[3]
Salaries and Benefits					
Refuge Manager - GS14	131,295	FTE	0.6	78,777	
Deputy Refuge Manager - GS13	111,111	FTE	0.8	88,889	
Asst. Refuge Manager (Sac/Del) – GS12	93,436	FTE	1.0	93,436	
Asst. Refuge Manager (Col/Sut) – GS12	93,426	FTE	1.0	93,426	
Natural Resources Planner - GS12	93,436	FTE	0.3	28,030	
Outdoor Recreation Planner - GS12	93,436	FTE	0.6	56,062	
Interpretive Specialist - GS9	64,430	FTE	0.8	51,544	
Interpretive Specialist – GS9 [Objectives 3.4 and 3.1, 3.2, 3.3, 3.5]	64,430	FTE	0.8	51,544	1
Law Enforcement Officer – GS9	74,343	FTE	0.5	37,172	
Law Enforcement Officer – GS7/9	74,343	FTE	0.5	37,172	
Law Enforcement Officer – GS7/9 [Objective 5.1]	74,343	FTE	0.5	37,172	3
Supv. Law Enforcement Officer – GS11 [Objective 5.1]	89,951	FTE	0.5	44,976	1
Supv. Wildlife Biologist - GS12	93,436	FTE	0.6	56,062	
Wildlife Biologist (Sac/Del) - GS11	77,957	FTE	1.0	77,957	
Wildlife Biologist (Col/Sut) - GS9	64,430	FTE	1.0	64,430	
Wildlife Biologist – GS9 [Objectives 1.1 and 1.2-1.4, 1.6-1.11, 2.1]	64,430	FTE	1.0	64,430	2
Wildlife Biologist – GS12	93,436	FTE	0.2	18,687	
Wildlife Biologist - GS5 [Objective 2.1]	42,523	FTE	1.0	42,523	2
Wildlife Biologist - GS5 [Objective 2.1]	42,523	FTE	1.0	42,523	3
Wildlife Biologist - GS5 [Objective 1.12]	42,523	FTE	1.0	42,523	2
Computer Specialist - GS11 [Objective 1.1 and Goals 1, 2, 3, 4, 5]	77,957	FTE	0.5	38,979	3
Facility Management Coord. – GS11 [Objective 5.3 and Goals 1, 2, 3, 4, 5]	77,957	FTE	0.5	38,979	1
Administrative Officer - GS9/11	77,957	FTE	0.6	46,774	
Budget Technician – GS6	47,400	FTE	0.6	28,440	
Budget Technician – GS6	47,400	FTE	0.6	28,440	
Purchasing Agent – GS5 [Objective 1.1 and Goals 1, 2, 3, 4, 5]	42,523	FTE	0.6	25,514	3
Office Automation Clerk - GS4/5	42,523	FTE	0.6	25,514	
Office Automation Clerk – GS5 [Objective 1.1 and Goals 1, 2, 3, 4, 5]	42,523	FTE	0.6	25,514	1
Office Automation Clerk – GS5 [Objective 3.1 and Goals 1, 2, 3, 4, 5]	42,523	FTE	0.6	25,514	2
Eng. Equip. Oper. Leader (Sac/Del) - WL10	78,254	FTE	1.0	78,254	
Eng. Equip. Oper. (Sac/Del) - WG10	71,143	FTE	1.0	71,143	
Eng. Equip. Oper. (Sac/Del) - WG10 [Objectives 1.1 and 1.2, 1.3, 1.4, 3.1, 3.2, 5.2, 5.3]	71,143	FTE	1.0	71,143	1
Eng. Equip. Oper. (Sac/Del) - WG8 [Objectives 1.1 and 1.2, 1.3, 1.4, 3.1, 3.2, 5.2, 5.3]	62,895	FTE	1.0	62,895	2

Eng. Equip. Oper. (Sac) - WG9	67,059	FTE	1.0	67,059	
Eng. Equip. Oper. (Del) - WG9	67,059	FTE	1.0	67,059	
Maint. Mechanic (Sac/Del) - WG9	67,059	FTE	1.0	67,059	
Tractor Operator (Sac) - WG6 [Objectives 1.1 and 1.2, 1.3, 1.4, 3.1, 3.2, 5.2, 5.3]	54,431	FTE	1.0	54,431	3
Tractor Operator (Del) - WG6 [Objectives 3.2 and 1.2, 1.3, 1.4, 3.1, 3.2, 5.2, 5.3]	54,431	FTE	1.0	54,431	2
Maint. Worker (Sac) - WG3 [Objectives 3.4 and 1.2, 1.3, 1.4, 3.1, 3.2, 5.2, 5.3]	42,209	FTE	1.0	42,209	2
Eng. Equip. Oper. (Col) - WG9	67,059	FTE	1.0	67,059	
Maint. Worker (Col/Sut) - WG8	62,895	FTE	1.0	62,895	
Eng. Equip. Oper. (Sut) - WG9	67,059	FTE	1.0	67,059	
Maintenance Worker (Sut) – WG8 [Objectives 3.2 and 1.2, 1.3, 1.4, 3.1, 3.2, 5.2, 5.3]	62,895	FTE	1.0	62,895	1
Fire Management Officer - GS12	107,811	FTE	0.5	53,906	
Asst. Fire Management Officer - GS11	89,951	FTE	0.5	44,976	
Prescribed Fire Specialist - GS9 [Objectives 1.1 and 1.2, 1.3, 1.4, 3.1, 3.2, 5.2, 5.3]	74,343	FTE	0.5	37,172	3
Fire Budget Technician – GS5/6 [Objectives 1.1 and 1.2, 1.3, 1.4, 3.1, 3.2, 5.2, 5.3]	47,400	FTE	0.5	23,700	1
Supv. Range Tech. (Fire) - GS8	67,313	FTE	0.5	33,657	
Supv. Range Tech. (Fire) - GS8	67,313	FTE	0.5	33,657	
Lead Range Tech (Fire) - GS6	54,693	FTE	0.5	27,347	
Lead Range Tech (Fire) - GS6	54,693	FTE	0.5	27,347	
Range Technician (Fire) - GS5	49,065	FTE	0.5	24,533	
Range Technician (Fire) - GS5	49,065	FTE	0.5	24,533	
Fire Crew (seasonal) - GS4	43,853	FTE	0.5	21,927	
Fire Crew (seasonal) - GS4	43,853	FTE	0.5	21,927	
Fire Crew (seasonal) - GS4	43,853	FTE	0.5	21,927	
Fire Crew (seasonal) - GS4	43,853	FTE	0.5	21,927	
Maintenance	$200,000	ea	1.0	$200,000	
Invasive Weed Program	$80,000	ea	1.0	$80,000	
Water/Pumping Costs	$25,000	ea	1.0	$25,000	
Water Quality Monitoring	$164,000	ea	1.0	$164,000	
Travel/Training	$24,000	ea	1.0	$24,000	
Supplies	$100,000	ea	1.0	$100,000	
Printing	$20,000	ea	1.0	$20,000	
Custodial Services	$1,598	ea	12.0	$19,176	
Wastewater Treatment Plant Operation	$1,530	mo	12.0	$18,360	
Grand Total:	**$4,426,779**			**$3,355,666**	

Shading indicates position identified in the CCP.
[1] Staffing and funding would be sought over the 15 year life of this plan subject to approval and funding by Congress.
[2] Unit Cost based on 2007 Grade level/Step 5 with 50 percent benefits for law enforcement and fire and 30 percent benefits for everyone else.
[3] Phase indicates a tiering or current priority ranking system that identifies which positions would be hired first when given approval and funding from Congress.

Figure 15. Sacramento Refuge Complex Staffing Plan.

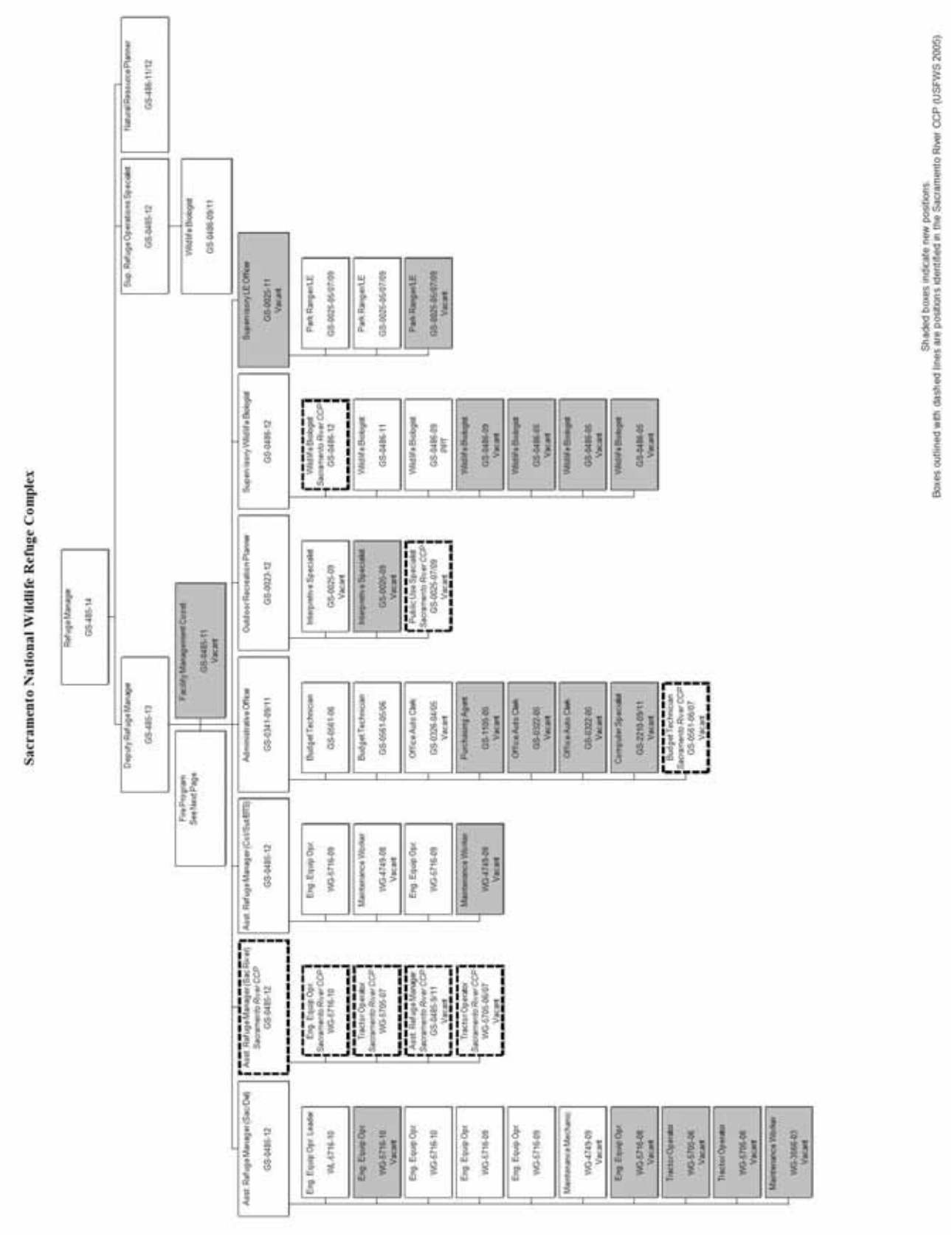
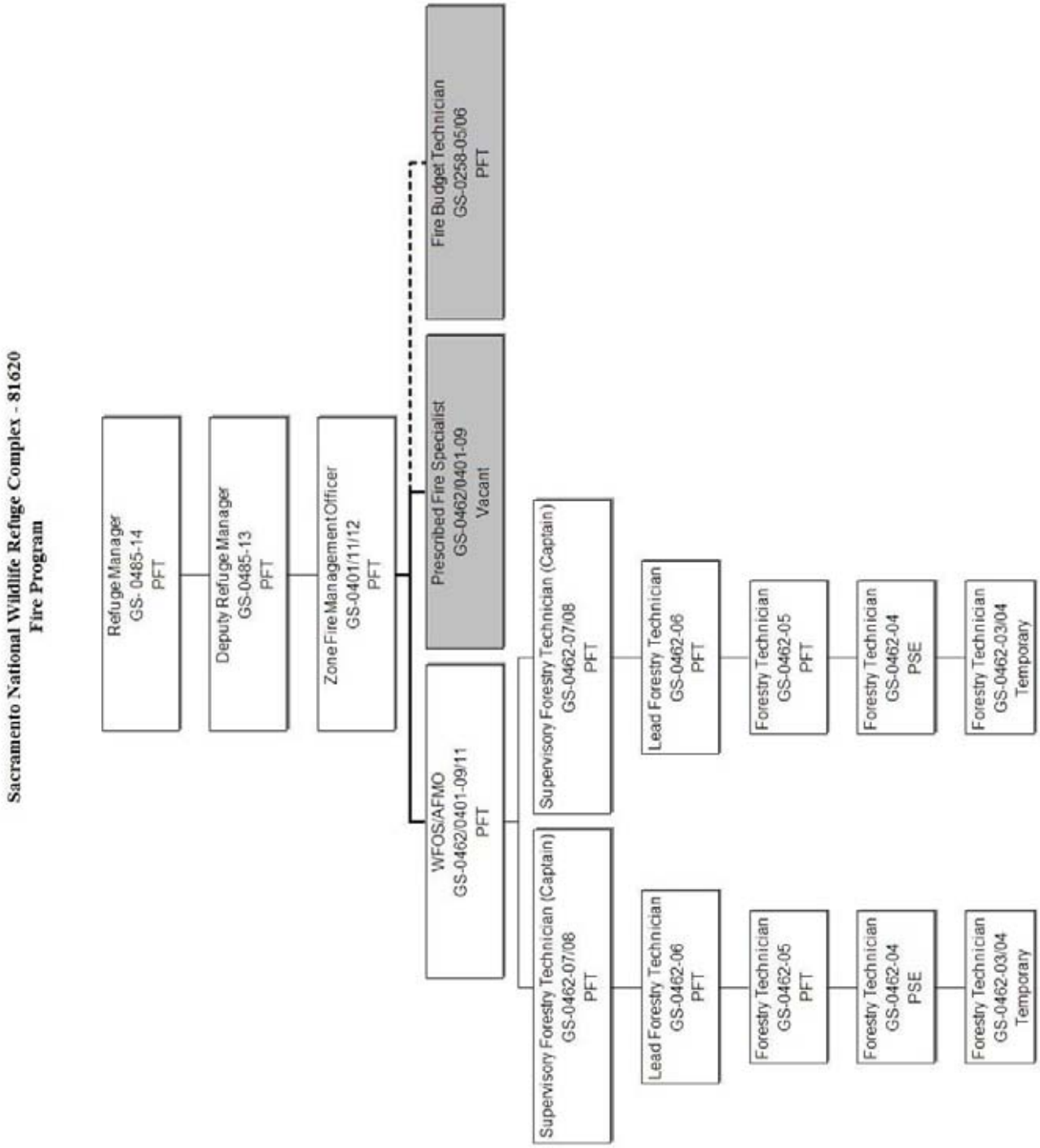


Figure 16. Fire Staffing Plan.



3. Step-Down Management Plan Summaries

Some projects or types of projects require more in-depth planning than the CCP process is designed to provide; for these projects, the Service prepares step-down management plans. In essence, step-down management plans provide the additional planning details necessary to implement management strategies identified in a CCP. Included in this document are eight step-down management plans. The CCP also proposes two new step down plans including a Law Enforcement Plan and a Pest Control Plan. These Plans will be completed by 2013.

3.1. Hunt Plan

The purpose of the Hunting Plan (Appendix C) is to establish guidelines for hunting on the Sacramento, Delevan, Colusa, and Sutter Refuges that will provide the public with a quality wildlife-dependent recreational experience, an opportunity to use a renewable resource, and the ability to maintain wildlife numbers at levels compatible with Refuge habitat. It was developed to provide safe hunting opportunities, while minimizing conflicts with other priority wildlife-dependent recreational uses. The plan will allow the hunting program to be conducted in a cost-effective manner, coordinated with the State. The hunting program will be reviewed annually by refuge staff during the Habitat Management Plan review conducted each spring. The activities within the Hunt Plan are evaluated within a hunting compatibility determination located in Appendix B.

3.2. Visitor Services Plan

The purpose of the Visitor Services Plan (Appendix D) is to establish guidelines for public uses on the Sacramento, Delevan, Colusa, and Sutter Refuges that will provide the public with a quality wildlife-dependent recreational experience. It was developed to provide safe wildlife-dependent recreation opportunities, while minimizing adverse impacts to the wildlife resources. The plan will allow the visitor services program to be conducted in a cost-effective manner. The program will be reviewed annually by refuge staff during the Habitat Management Plan review conducted each spring. The activities within the Visitor Services Plan are evaluated within compatibility determinations (hunting, wildlife observation and photography, environmental education and interpretation, and bicycling) located in Appendix B.

3.3. Habitat Management Plan

Refuge staff has developed annual Habitat Management Plans for Sacramento, Delevan, Colusa, and Sutter Refuges, which guide the refuge manager in the decision making process (Appendix E). Each unit is visited annually by a team of managers, biologists, recreation planners, and maintenance workers to identify resource issues, develop a prioritized list of projects to address those issues, and monitor outcomes/responses. The database for this planning document is annually updated. The plan is based on an adaptive management philosophy that allows the team to assess habitat condition and wildlife use of the units annually and make adjustments accordingly in order to meet the Refuges' goals and objectives.

California goldfields and Hoover's downingia
Photo by Joe Silveira

3.4. Integrated Pest Management Plan

The Complex has developed an Integrated Pest Management (IPM) Plan (Appendix F) to address/reduce public nuisance and human health risk from mosquito-transmitted diseases, as well as to address invasive and exotic plants on the Refuges. The purposes of this plan are: to identify mosquito control methods and materials currently approved for use on the Complex; identify use in an IPM program that is consistent with the goals of the Complex and minimizes public health risk from Refuge-harbored mosquitoes; and provide long-term planning to meet the Service's goal of reducing effects of pesticide use on DOI trust resources to the greatest extent possible. This plan will be reviewed and updated to include new information and policy changes as needed. It covers chemical herbicide/pesticide use (aerial and ground application), mechanical eradication, and biological controls. Mosquito monitoring and control activities are evaluated within a compatibility determination located in Appendix B

3.5. Resource Inventory and Monitoring Plan

The purpose of the Wildlife Inventory and Monitoring Plan (Appendix G) is to establish guidelines and a schedule for conducting routine surveys to inventory and monitor wildlife and plant

populations on the Refuges. It was developed to maintain consistency in the timing and methods used to collect population and habitat data between years.

3.6. Waterfowl Disease Contingency Plan

The purpose of the Waterfowl Disease Contingency Plan (Appendix H) is to establish protocols for monitoring and responding to wildlife disease outbreaks on the Refuges. It was developed to ensure a safe working environment for personnel involved in associated disease monitoring and clean-up activities while minimizing wildlife losses.

3.7. Water Management Plan

Annual Water Management Plans (Appendix I) are prepared for Sacramento, Delevan, and Colusa Refuges. The development of these plans is a requirement of the Central Valley Project Improvement Act (CVPIA), which requires the Bureau of Reclamation to purchase and deliver water to these Refuges. The plan outlines water management goals and objectives and inventories existing facilities, water quality monitoring, water inventory, and best management practices.

3.8. Fire Management Plan

The Department of the Interior (DOI) fire management policy requires that all refuges with vegetation that can sustain fire must have a Fire Management Plan (FMP) (Appendix J) that details fire management guidelines for operational procedures and values to be protected or enhanced. The FMP for the Sacramento, Delevan, Colusa, and Sutter Refuges provides guidance on preparedness, prescribed fire, wildland fire, and prevention. Values to be considered in the FMP include protection of Refuge resources and neighboring private properties, effects of burning on Refuge habitats/biota, and firefighter safety. Refuge resources include properties, structures, cultural resources, trust species (including endangered, threatened, and species of special concern), and their associated habitats. The FMP will be reviewed periodically to ensure that the fire program is conducted in accordance with the Service's mission and the Refuges' purposes, goals, and objectives.

This plan is written to provide guidelines for appropriate suppression and prescribed fire programs at Sacramento, Delevan, Colusa, and Sutter Refuges. Prescribed fires may be used to reduce hazard fuels, restore the natural processes and vitality of ecosystems, improve wildlife habitat, remove or reduce non-native species, and/or conduct research. This plan will help achieve resource management objectives by enabling the Refuge to use prescribed fire, as one of several tools, to control non-native vegetation, and reduce fire hazards in grassland and riparian habitats. It will be used in conjunction with other management tools that are currently applied on Refuge properties (i.e., grazing, mowing and herbicide applications) to meet resource objectives.

4. Appropriate Use Requirements

The Appropriate Use policy describes the initial decision process the refuge manager follows when first considering whether or not to allow a proposed use on a refuge. The refuge manager must find a use is appropriate before undertaking a compatibility review of the use. Uses that have been administratively determined to be appropriate are the six wildlife-dependent recreational uses (hunting, fishing, wildlife observation and photography, environmental education, and interpretation) and the take of fish and wildlife under State regulations.

A review of appropriateness of existing and proposed Refuge uses was completed for the Refuges. Bicycling, commercial photography, plant material gathering, grazing, mosquito control, research, and walking were found to be appropriate uses on the Refuges. Camping, field dog trials, horseback riding, memorials, oil and gas exploration, and weddings were found to be not appropriate uses on the Refuges.

Western kingbird
Photo by Mike Peters

5. Compatibility Determinations

Federal law and policy provide the direction and planning framework to protect the Refuge System from incompatible or harmful human activities and to insure that Americans can enjoy Refuge System lands and waters. The Improvement Act is the key legislation on managing public uses and compatibility.

Before activities or uses are allowed on a refuge, uses must be found to be “compatible” through a written compatibility determination. A compatible use is defined as a proposed or existing wildlife-dependent recreational use or any other use of a national wildlife refuge that, based on sound professional judgment, will not materially interfere with or detract from the fulfillment of the Refuge System mission or the purposes of the national wildlife refuge. Sound professional judgment is defined as a decision that is consistent with the principles of the fish and wildlife management and administration, available science and resources, and adherence to the requirements of the

Improvement Act, and other applicable laws. Wildlife-dependent recreational uses may be authorized on a refuge when they are compatible and not inconsistent with public safety.

Compatibility determinations for hunting, wildlife observation, photography, commercial photography, environmental education, interpretation, bicycling, grazing, plant material gathering, and mosquito and other vector control are included in Appendix B. These uses were all found to be compatible.

6. Compliance Requirements

This CCP was developed to comply with all Federal laws, executive orders, and legislative acts to the extent possible. Some activities (particularly those that involve a major revision to an existing step-down management plan, or preparing a new plan) would need to comply with additional laws or regulations besides NEPA and the Improvement Act. A list of the Federal laws, executive orders and legislative acts is in Appendix M.

7. Monitoring and Evaluation

The CCP is designed to be effective for a 15-year period. The plan will be reviewed and revised as required to ensure that established goals and objectives are still applicable and that the CCP is implemented as scheduled. The monitoring program will focus on issues involving visitor service activities, habitat management programs, wildlife inventory, and other monitoring and management activities. Monitoring and evaluation will use the adaptive management process. This process includes goal and objective setting, and applying management tools and strategies followed by monitoring and analysis to measure achievement of objectives and refine management techniques.

Collection of baseline data on wildlife populations will continue. This data will be used to update existing species lists, wildlife habitat requirements, and seasonal use patterns. Migratory and resident birds, raptors, and species of management concern will be the focus of monitoring efforts.

Where information gaps exist, a concerted effort will be made to obtain information. With new information, goals and objectives may need modification. Public involvement will be encouraged during the evaluation process.

Monitoring of visitor service programs will involve the continued collection of visitor use statistics. Monitoring will be done to evaluate the effects of public use on Refuge habitat, wildlife populations, and visitor experience.

8. Adaptive Management

Adaptive management is the process of implementing policy decisions as scientifically driven experiments that test predictions and assumptions about management plans, using the resulting information to improve the plans. Adaptive management provides the framework within which biological measures and public use can be evaluated by comparing the results of management to results expected from objectives. Management direction is periodically evaluated within a system that applies several options, monitors the objectives, and adapts original strategies to reach desired objectives. Habitat, wildlife, and visitor service management techniques and specific objectives would be regularly evaluated as results of a monitoring program and other new technology and information become available. These periodic evaluations would be used over time to adapt both the management objectives and strategies to better achieve management goals. Such a system embraces uncertainty and provides new information for future decision-making while allowing resource use.

Horned lark
Photo by Steve Emmons

9. CCP Plan Amendment and Revision

The CCP is intended to evolve as the Refuges change, and the Improvement Act specifically requires that CCPs be formally revised and updated at least every 15 years. The formal revision process would follow the same steps as the CCP creation process. In the meantime, the Service would be reviewing and updating this CCP periodically based on the results of the adaptive management program. While preparing annual work plans and updating the Refuge database, refuge staff will also review the CCP. It may also be reviewed during routine inspections or programmatic evaluations. Results of any or all of these reviews may indicate a need to modify the plan. The goals described in this CCP would not change until they are reevaluated as part of the formal CCP revision process. However, the objectives and strategies may be revised to better address changing circumstances or to take advantage of increased knowledge of the resources on the Refuge. It is the intent of the Service to have

the CCP apply to any new lands that may be acquired. If changes are required, the refuge manager would determine the level of public involvement and associated NEPA documentation.

The intent of the CCP is for the Refuges' objectives and strategies to be attained over the next 15 years. Management activities would be phased in over time and implementation is contingent upon and subject to results of monitoring and evaluation, funding through Congressional appropriations and other sources, and staffing.

Red-shouldered hawk
Photo by Steve Emmons

Glossary

Adaptive Management: The rigorous application of management, research, and monitoring to gain information and experience necessary to assess and modify management activities. A process that uses feedback from refuge research and monitoring and evaluation of management actions to support or modify objectives and strategies at all planning levels (Service Manual 602 FW 1.6).

Alluvial: Pertaining to clay, silt, sand, gravel or other sedimentary matter deposited by flowing water, usually within a river valley.

Alternatives: Different sets of objectives and strategies or means of achieving refuge purposes and goals, helping fulfill the Refuge System mission, and resolving issues. (1) A reasonable way to fix the identified problem or satisfy the stated need. (40 CFR 150.2) (2) Alternatives are different sets of objectives and strategies or means of achieving refuge purposes and goals, helping fulfill the Refuge System mission, and resolving issues (Service Manual 602 FW 1.6).

Aquatic: Pertaining to water, in contrast to land. Living in or upon water.

Aquatic Habitat: The physical, chemical, and vegetative features that occur within the water of lakes, ponds, reservoirs, rivers, irrigation canals, and other bodies of water.

Artifact: An object made by humans; usually in reference to primitive tools, vessels, weapons, etc.

ATV: All Terrain Vehicle (either 3 or 4-wheeled vehicles).

Biodiversity (biological diversity): Refers to the full range of variability within and among biological communities, including genetic diversity, and the variety of living organisms, assemblages of living organisms, and biological processes. Diversity can be measured in terms of the number of different items (species, communities) and their relative abundance, and it can include horizontal and vertical variability. The variety of life, including the variety of living organisms, the genetic differences among them, and the communities in which they occur.

Biological Control: The use of organisms or viruses to control weeds or other pests.

Biological Integrity: Biotic composition, structure, and functioning at the genetic, organism, and community levels consistent with natural conditions, including the natural biological processes that

shape genomes, organisms, and communities (Service Manual 602 FW 1.6).

Biota: The plant and animal life of a region.

Categorical Exclusion (CE, CX, CATEX, CATX): A category of actions that do not individually or cumulatively have a significant effect on the human environment and have been found to have no such effect in procedures adopted by a Federal agency pursuant to the National Environmental Policy Act (40 CFR 1508.4).

CFR: Code of Federal Regulations.

Compatible Use: A proposed or existing wildlife-dependent recreational use or any other use of a national wildlife refuge that, based on sound professional judgment, will not materially interfere with or detract from the fulfillment of the National Wildlife Refuge System mission or the purposes of the national wildlife refuge (Service Manual 603 FW 2.6).

Compatibility Determination: A written determination signed and dated by the refuge manager and Regional Chief signifying that a proposed or existing use of a national wildlife refuge is a compatible use or is not a compatible use. The Director makes this delegation through the Regional Director (Service Manual 603 FW 2.6).

Comprehensive Conservation Plan (CCP): A document that describes the desired future conditions of the refuge or planning unit and provides long-range guidance and management direction to achieve the purposes of the refuge, helps fulfill the mission of the Refuge System; maintains and, where appropriate, restores the ecological integrity of each refuge and the Refuge System; helps achieve the goals of the National Wilderness Preservation System; and meets other mandates (Service Manual 602 FW 1.6).

Cultural Resource: The physical remains of human activity (artifacts, ruins, petroglyphs, etc.) and conceptual content or context of an area such as a traditional sacred site. It includes historically, archaeologically and architecturally significant resources.

Cultural Resource Inventory: A professionally conducted study designed to locate and evaluate evidence of cultural resources present within a defined geographic area. Inventories may involve various levels, including background literature search, comprehensive field examination to identify all exposed physical manifestations of cultural resources, or sample inventory to project site distribution and density over a larger area. Evaluation of identified cultural resources to determine eligibility for the National Register follows the criteria found in 36 CFR 60.4 (Service Manual 614 FW 1.7).

Cultural Resource Overview: A comprehensive document prepared for a field office that discusses, among other things, its prehistory and cultural history, the nature and extent of known cultural resources, previous research, management objectives, resource management conflicts or issues, and a general statement on how program objectives should be met and conflicts resolved. An overview should reference or incorporate information from a field offices background or literature search described in Section VIII of the Cultural Resource Management Handbook (Service Manual 614 FW 1.7).

Deposits: Material that is laid down through the actions of wind, water, ice, or other natural process.

Diversion: A structure in a river or canal that diverts water from the river or canal to another water course.

Drain: A canal that collects and transports excess water from irrigated farmland.

Easement: A privilege or right that is held by one person or other entity in land owned by another.

Ecological Integrity: The integration of biological integrity, natural biological diversity, and environmental health; the replication of natural conditions (Service Manual 602 FW 1.6).

Ecology: The branch of biology that studies the interactions of organisms within an environment, either with other organisms (biotic factors) or with the non-living components (abiotic factors) of that ecosystem.

Ecosystem: The sum of all interacting parts of the environment and associated ecological communities within a particular area; an ecological system. Many levels of ecosystems have been recognized. Very few, if any ecosystems are self-contained; most influence, or are influenced by, components or forces outside the system. For administrative purposes, we have designated 53 ecosystems covering the United States and its possessions. These ecosystems generally correspond with watershed boundaries, and their sizes and ecological complexity vary.

Ecosystem Approach: Protecting or restoring the natural function (processes), structure (physical and biological patterns), and species composition of an ecosystem, recognizing that all components are interrelated.

Effect: A change in a resource, caused by a variety of events including project attributes acting on a resource attribute (direct), not directly acting on a resource attribute (indirect), another project

attributes acting on a resource attribute (cumulative), and those caused by natural events (e.g., seasonal change).

Emergent Vegetation: Rooted, aquatic plants that have most of their vegetative (non-root) parts above water.

Endemic Species: Plants or animals that occur naturally in a certain region and whose distribution is relatively limited to a particular locality.

Endangered Species: Any species that is in danger of extinction throughout all or a significant portion of its range and listed as such by the Secretary of the Interior in accordance with the Endangered Species Act of 1973. Endangered species are afforded protection under the Act as amended and under various State laws for State-listed species.

Environment: The sum total of all biological, chemical, and physical factors to which organisms are exposed; the surroundings of a plant or animal.

Environmental Assessment (EA): A concise public document, prepared in compliance with the National Environmental Policy Act, that briefly discusses the purpose and need for an action, alternatives to such action, and provides sufficient evidence and analysis of impacts to determine whether to prepare an environmental impact statement or finding of no significant impact (40 CFR 1508.9).

Environmental Education: A process designed to develop a citizenry that has the awareness, concern, knowledge, attitudes, skills, motivation, and commitment to work toward solutions of current environmental problems and the prevention of new ones. Environmental education within the National Wildlife Refuge System incorporates materials, activities, programs, and products that address the citizen's course of study goals, the objectives of the refuge/field station, and the mission of the Refuge System.

Environmental Health: Abiotic composition, structure, and functioning of the environment consistent with natural conditions, including the natural abiotic processes that shape the environment (Service Manual 602 FW 1.6).

Environmental Impact Statement (EIS): A detailed written statement required by section 102(2) (C) of the National Environmental Policy Act, analyzing the environmental impacts of a proposed action, adverse effects of the project that cannot be avoided, alternative courses of action, short-term uses of the environment versus the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitment of resources (40 CFR 1508.11).

Ephemeral: Pertains to streams, lakes and wetlands that exist temporarily each year.

Evapotranspiration: The collective processes by which water is transferred from the surface of the earth, including from the soil and the surface of water-bodies (through evaporation) and from plants (through transpiration).

Evolutionary Significant Unit (ESU): A sub-population of a species that is defined by substantial reproductive isolation from other conspecific units and represents an important component of the evolutionary legacy of the species.

Exotic and Invading Species. (Noxious Weeds): Plant species designated by Federal or State law as generally possessing one or more of the following characteristics: aggressive or difficult to manage; parasitic; a carrier or host of serious insects or disease; or nonnative, new, or not common to the United States, according to the Federal Noxious Weed Act (PL 93-639), a noxious weed is one that causes disease or has adverse effects on man or his environment and therefore is detrimental to the agriculture and commerce of the Unite States and to the public health.

Fallow: Allowing land that normally is used for crop production to lie idle.

Federal Trust Resources: A trust is something managed by one entity for another who holds the ownership. The Service holds in trust many natural resources for the people of the United States of America as a result of Federal Acts and treaties. Examples are species listed under the Endangered Species Act, migratory birds protected by the Migratory Bird Treaty Act and other international treaties, and native plant or wildlife species found on the Refuge System.

Finding of No Significant Impact (FONSI): A document prepared in compliance with the National Environmental Policy Act, supported by an environmental assessment, that briefly presents why a Federal action will have no significant effect on the human environment and for which an environmental impact statement, therefore, will not be prepared (40 CFR 1508.13).

Floodplain: The relatively flat area along the sides of a river which is naturally subjected to flooding.

Fluvial: Pertaining to a river.

Flyway: A route taken by migratory birds between their breeding grounds and their wintering grounds. Four primary migration routes

have been identified for birds breeding in North America: the Pacific, Central, Mississippi, and Atlantic Flyways.

Foraging: The act of feeding; another word for feeding.

Forbs: Herbaceous dicotyledonous plants.

Fragmentation: The process of reducing the size and connectivity of habitat patches.

GIS: Geographic Information System. Refers to such computer mapping programs as ArcView, ArcInfo, ERDAS, etc.

Goal: Descriptive, open-ended, and often broad statement of desired future conditions that conveys a purpose but does not define measurable units (Service Manual 620 FW 1.6).

Habitat: Suite of existing environmental conditions required by an organism for survival and reproduction. The place where an organism typically lives.

Habitat Restoration: Management emphasis designed to move ecosystems to desired conditions and processes, and/or to healthy forestlands, rangelands, and aquatic systems.

Halophytes: Salt-tolerant plant species.

Hydrologic Regime: The local pattern and magnitude of water flow influenced by season.

Hydrology: The science dealing with the properties, distribution, and circulation of water on and below the earth's surface and in the atmosphere. The distribution and cycling of water in an area.

Impoundment: A body of water created by collection and confinement within a series of levees or dikes thus creating separate management units although not always independent of one another.

Impact: See effect.

Indigenous: Native to the area.

Integrated Pest Management (IPM): The control of pests utilizing a practical, economical and scientifically based combination of biological, physical, cultural and chemical control methods. Integrated pest management emphasizes these methods in order to reduce or eliminate the need for chemical pesticides. It is a balanced approach, which considers hazard to the environment, efficacy, costs and vulnerability of the pest (Service Administrative Manual 30 AM 12).

Interpretation: Interpretation can be an educational and recreational activity that is aimed at revealing relationships, examining systems, and exploring how the natural world and human activities are interconnected.

Invasive species: A species that is a non-native (or alien) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health. (Executive Order 13112). Invasive species can be plants, animals, and other organisms (e.g., microbes). Human actions are the primary means of invasive species introductions.

Invertebrate: Animals that do not have backbones. Included are insects, spiders, mollusks (clams, snails, etc.), and crustaceans (shrimp, crayfish, etc.).

Irrigation Drainwater: Ideally, subsurface water which flows from irrigated land and generally transports higher concentrations of dissolved salts than the water applied to the land.

Issue: Any unsettled matter that requires a management decision, e.g., an initiative, opportunity, resource management problem, threat to the resources of the unit, conflict in uses, public concern, or the presence of an undesirable resource condition (Service Manual 602 FW 1.6).

Landowner: A person or entity indicated as the owner of property on the various ownership maps maintained by the Office of the County Assessor.

Landscape Ecology: A sub-discipline of ecology, which focuses on spatial relationships and interactions between patterns and processes. This emerging science integrates hydrology, geology, geomorphology, soil science, vegetation science, wildlife science, economics, sociology, law, engineering and land use planning to conserve, enhance, restore and protect the sustainability of ecosystems on the land.

Lease: A legal contract by which water rights are acquired for a specified period of time for a specified rent or compensation.

Levee: An embankment along the river to prevent water from over bank flooding.

Marsh: A periodically wet or continually flooded area where the water is shallow enough to allow the growth of emergent vegetation such as sedges, rushes, and cattails.

Meander: The bend of curve in a river or stream channel. Migration of the river or stream channel.

Migration: The seasonal movement from one area to another and back.

Migratory Bird: A bird that seasonally moves between geographic areas. In reference to birds in the Great Basin, a bird that breeds in Great Basin and subsequently moves south of the Great Basin for the winter months. Birds that migrate south of Mexico for the winter are considered Neotropical migrants.

Mission Statement: Succinct statement of the unit's purpose and reason for being.

Mitigation: To avoid or minimize impacts of an action by limiting the degree or magnitude of the action; to rectify the impact by repairing, rehabilitating, or restoring the affected environment; to reduce or eliminate the impact by preservation and maintenance operations during the life of the action.

Moist-Soil: A process where water is drawn down intentionally or naturally to produce mudflats (i.e., moist soil) that is required for germination of many desirable plants.

Monitoring: Data collected and analyzed periodically for comparing trends in that which is being monitored. Monitoring is necessary to identify, track and analyze results of management actions at the refuge so that future management actions may be adapted to obtain the best benefits to wildlife and habitat (see adaptive management).

National Environmental Policy Act (NEPA): An act which encourages productive and enjoyable harmony between humans and their environment, to promote efforts that will prevent or eliminate damage to the environment and atmosphere, to stimulate the health and welfare of humans. The act also established the Council on Environmental Quality (CEQ). Requires all agencies, including the Service, to examine the environmental impacts of their actions, incorporate environmental information, and use public participation in the planning and implementation of all actions. Federal agencies must integrate NEPA with other planning requirements, and prepare appropriate NEPA documents to facilitate better environmental decision making (from 40 CFR 1500).

National Wildlife Refuge (Refuge or NWR): A designated area of land or water or an interest in land or water within the system, including national wildlife refuges, wildlife ranges, wildlife management areas, waterfowl production areas, and other areas (except coordination areas) under the Service jurisdiction for the protection and conservation of fish and wildlife. A complete listing of

all units of the Refuge System may be found in the current AReport of Lands Under Control of the U.S. Fish and Wildlife Service@ (Service Manual 602 FW 1.6).

National Wildlife Refuge System (Refuge System): Various categories of areas that are administered by the Secretary for the conservation of fish and wildlife, including species that are threatened with extinction; all lands, waters, and interest therein administered by the Secretary as wildlife refuges; areas for the protection and conservation of fish and wildlife that are threatened with extinction; wildlife ranges; game ranges; wildlife management or waterfowl production areas.

National Wildlife Refuge System Mission (mission): "The mission of the System is to administer a national network of lands and waters for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans" (Service Manual 602 FW 1.6).

Natural Recruitment: Plant establishment through natural processes. In riparian systems these processes include: flooding, sediment deposition, erosion, and seed dispersal from local or upstream plant sources.

Native Species: Species that normally live and thrive in a particular ecosystem.

Neotropical Migratory Birds: Migratory birds that breed in North American and winter in Central and South America.

NEPA: National Environmental Policy Act of 1969.

Niche: An organism's "place," or role, in an ecosystem. This involves many components of the organism's life: where it lives (habitat), what it eats, by whom it is eaten, when it migrates or breeds, etc. All of these factors combine to determine the role of the organism in its ecosystem.

No Action Alternative: An alternative under which existing management would be continued.

Non-Priority Public Uses: Any use other than a compatible wildlife-dependent recreational use.

Notice of Intent (NOI): A notice that an environmental impact statement will be prepared and considered (40 CFR 1508.22). Published in the *Federal Register*.

NWR: National Wildlife Refuge.

Objective: A concise statement of what we want to achieve, how much we want to achieve, when and where we want to achieve it, and who is responsible for the work. Objectives derive from goals and provide the basis for determining strategies, monitoring refuge accomplishments, and evaluating the success of strategies. Make objectives attainable, time-specific, and measurable (Service Manual 602 FW 1.6).

One-hundred-year Floodplain: The relatively flat portion of the river channel that has a one percent chance of being inundated by flood water in any given year.

Outreach: Outreach is two-way communication between the USFWS and the public to establish mutual understanding, promote involvement, and influence attitudes and actions, with goal of improving joint stewardship of our natural resources.

Over bank Flooding: River flows that exceed the boundaries of the existing river channel and flood the adjacent riparian areas and bottomlands.

Oxbow Lake: A horseshoe-shaped lake formed in an abandoned meander bend of a river.

Passerine Bird: A songbird or other perching bird that is in the order Passeriformes. Blackbirds, crows, warblers, sparrows, and wrens for example.

Perennial: In reference to a body of water, one that contains water year-to-year and that rarely goes dry.

Peak Flow: The maximum discharge of a stream during a specified period of time.

Pest: Any terrestrial or aquatic plant or animal which interferes, or threatens to interfere, at an unacceptable level, with the attainment of refuge objectives or which poses a threat to human health (Refuge Manual 7 RM 14).

Phenology: Life cycle of particular species.

Physiographic: Physical geography of a particular region of the U.S.

PILT: Payment-in-Lieu-of-Taxes.

Planning Area: The area upon which the planning effort will focus. A planning area may include lands outside existing planning unit boundaries currently studied for inclusion in the Refuge System and/or partnership planning efforts. It also may include watersheds

or ecosystems outside of our jurisdiction that affect the planning unit. At a minimum, the planning area includes all lands within the authorized boundary of the refuge (Service Manual 602 FW 1.6).

Planning Team: A team or group of persons working together to prepare a document. Planning teams are interdisciplinary in membership and function. Teams generally consist of a planning team leader, refuge manager and staff biologists, a state natural resource agency representative, and other appropriate program specialists (e.g., social scientist, ecologist, recreation specialist). We also will ask other Federal and Tribal natural resource agencies to provide team members, as appropriate. The planning team prepares the CCP and appropriate NEPA documentation (Service Manual 602 FW 1.6).

Planning Team Leader: The planning team leader typically is a professional planner or natural resource specialist knowledgeable of the requirements of NEPA and who has planning experience. The planning team leader manages the refuge planning process and ensures compliance with applicable regulatory and policy requirements (Service Manual 602 FW 1.6).

Planning Unit: A single refuge, an ecologically or administratively related refuge complex, or distinct unit of a refuge. The planning unit also may include lands currently outside refuge boundaries (Service Manual 602 FW 1.6).

Plant Community: An assemblage of plant species of a particular composition. The term can also be used in reference to a group of one or more populations of plants in a particular area at a particular point in time; the plant community of an area can change over time due to disturbance (e.g., fire) and succession.

Pollutant: Any introduced gas, liquid, or solid that makes a resource unfit for a specific purpose.

Population: All the members of a single species coexisting in one ecosystem at a given time.

Preferred Alternative: This is the alternative determined (by the decision maker) to best achieve the Refuge purpose, vision, and goals; contributes to the Refuge System mission, addresses the significant issues; and is consistent with principles of sound fish and wildlife management. The Service=s selected alternative at the Draft CCP stage.

Prescribed Fire: The skillful application of fire to natural fuels under conditions of weather, fuel moisture, soil moisture, etc., that allows confinement of the fire to a predetermined area and produces the intensity of heat and rate of spread to accomplish planned benefits to

one or more objectives of habitat management, wildlife management, or hazard reduction.

Priority Public Uses: Compatible wildlife-dependent recreation uses (hunting, fishing, wildlife observation and photography, and environmental education and interpretation).

Proposed Action: The Service=s proposed action for Comprehensive Conservation Plans is to prepare and implement the CCP.

Public: Individuals, organizations, and groups; officials of Federal, State, and local government agencies; Indian tribes; and foreign nations. It may include anyone outside the core planning team. It includes those who may or may not have indicated an interest in Service issues and those who do or do not realize that Service decisions may affect them.

Public Involvement: A process that offers impacted and interested individuals and organizations an opportunity to become informed about, and to express their opinions on Service actions and policies. In the process, these views are studied thoroughly and thoughtful consideration of public views is given in shaping decisions for refuge management.

Public Scoping: Using news releases to the local media and other appropriate means, notify the affected public of the opportunity to participate in the preparation of the CCP and begin the scooping process. Involve the public and gather comments on any existing planning unit vision statement and goals. Encourage the public to help identify potential issues, management actions and concerns, significant problems or impacts, and opportunities or alternatives to resolve them (Service Manual 602 FW 3).

Purposes of the Refuge: "The purposes specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, refuge unit, or refuge subunit." For refuges that encompass congressionally designated wilderness, the purposes of the Wilderness Act are additional purposes of the refuge (Service Manual 602 FW 1.6).

Raptor: A bird of prey, such as a hawk, eagle, or owl.

Record of Decision (ROD): A concise public record of decision prepared by the Federal agency, pursuant to NEPA, that contains a statement of the decision, identification of all alternatives considered, identification of the environmentally preferable alternative, a statement as to whether all practical means to avoid or minimize environmental harm from the alternative selected have been adopted

(and if not, why they were not), and a summary of monitoring and enforcement where applicable for any mitigation (40 CFR 1505.2).

Recruitment: The annual increase in a population as determined by the proportion of surviving offspring produced during a specific period (usually expressed per year).

Refuge: Short of National Wildlife Refuge.

Refuge Goal: See goal.

Refuge Operating Needs System (RONS): The Refuge Operating Needs System is a national database that contains the unfunded operational needs of each refuge. We include projects required to implement approved plans and meet goals, objectives, and legal mandates (Service Manual 602 FW 1.6).

Refuge Purposes: See purposes of the Refuge.

Refuge Revenue Sharing Program or RRSP: Proves payments to counties in lieu of taxes using revenues derived from the sale of products from refuges.

Refuge Use: Any activity on a refuge, except administrative or law enforcement activity carried out by or under the direction of an authorized Service employee.

Restoration: The return of an ecosystem to an approximation of its former unimpaired condition.

Riparian Area: Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., a zone of influence). Riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes and estuarine-marine shorelines.

Riparian Habitat: Gravel bars, sand dunes, non-vegetated riverbanks, herbaceous, scrub and forested vegetation, which provides habitat for plants, macro-invertebrates, fish and wildlife.

Riverine: Pertaining to rivers and floodplains.

Secretary: Short of the Secretary of the Interior.

Sediment: Any material, carried in suspension by water, which ultimately settles to the bottom of water courses. Sediments may also settle on stream banks or flood plains during high water flow.

Service or USFWS: Short for U.S. Fish and Wildlife Service.

Shorebirds: Long-legged birds, also known as waders, belonging to the Order Charadriiformes that use shallow wetlands and mud flats for foraging and nesting.

Slough: A naturally occurring side or overflow channel that holds water.

Soil Erosion: The wearing away of the land's surface by water, wind, ice, or other physical process.

Sound Professional Judgment: A finding, determination, or decision that is consistent with principles of sound fish and wildlife management and administration, available science and resources, and adherence to the requirements of the Refuge Administration Act of 1966 (16 U.S.C. 668dd-668ee), and other applicable laws. Included in the finding, determination, or decision is a refuge manager's field experience and knowledge of the particular refuge's resources (Service Manual 603 FW 2.6).

Species: A distinctive kind of plant or animal having distinguishable characteristics, and that can interbreed and produce young. A category of biological classification.

Species Composition: A group of species that inhabit a specific habitat type in its healthy state. To enhance species composition is to ensure that all or as many species as possible inhabit the appropriate habitat by improving the quality of that habitat.

Step-Down Management Plan: A plan that provides specific guidance on management subjects (e.g., habitat, public use, fire, safety) or groups of related subjects. It describes strategies and implementation schedules for meeting CCP goals and objectives (Service Manual 602 FW 1.6).

Strategy: A specific action, tool, or technique or combination of actions, tools, and techniques used to meet unit objectives (Service Manual 602 FW 1.6).

Submergent Vegetation: Plants that grows completely submerged except when flowering.

Succession: The replacement of one plant community by another over time.

Surface Water: A body of water that has its upper surface exposed to the atmosphere.

System or Refuge System: National Wildlife Refuge System.

Threatened Species: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range, and one that has been designated as a threatened species in the *Federal Register* by the Secretary of the Interior. Threatened species are afforded protection under the Endangered Species Act of 1973.

Trust Species: Species for which the U.S. Fish and Wildlife Service has primary responsibility, including, most federally listed threatened and endangered species, anadromous fishes once they enter inland U.S. waterways, migratory birds, and certain marine mammals.

Understory: Shrubs and herbaceous plants that typically grow beneath larger trees in a woodland.

Upland: An area where water normally does not collect and where water does not flow on an extended basis. Uplands are non-wetland areas.

USFWS or Service: Short for U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service Mission: Our mission is working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people (Service Manual 602 FW 1.6).

Vegetation: The composition plant species, their frequency of occurrence, density, and age classes at a specified scale.

Vegetation Type or Habitat Type: A land classification system based upon the concept of distinct plant associations.

Vernal Pool: Seasonally flooded depressions on soils with an impermeable layer such as a hardpan, claypan, volcanic basalt, or saturated alkali clays. The impermeable layer allows the pools to retain water much longer then the surrounding uplands; nonetheless, the pools are shallow enough to dry up each season. Vernal pools often fill and empty several times during the rainy season. Only plants and animals that are adapted to this cycle of wetting and drying can survive in vernal pools over time.

Vertebrate: An animal having a segmented backbone or vertebral column; includes mammals, birds, fish, amphibians, and reptiles.

Vision Statement: A concise statement of what the planning unit should be, or what we hope to do, based primarily upon the Refuge System mission and specific refuge purposes, and other mandates. We will tie the vision statement for the refuge to the mission of the Refuge System; the purpose(s) of the refuge; the maintenance or restoration of the ecological integrity of each refuge and the Refuge System; and other mandates (Service Manual 602 FW 1.6).

Waterfowl: A group of birds that include ducks, geese, and swans (belonging to the order Anseriformes).

Water Rights: A grant, permit, decree, appropriation, or claim to the use of water for beneficial purposes, and subject to other rights of earlier date of use, called priority, or prior appropriation.

Watershed: The entire land area that collects and drains water into a river or river system.

Wetland: Land that is transitional between upland (terrestrial) and aquatic systems (greater than about 6-feet deep) where the water table is usually at or near the surface or the land is covered by shallow water... wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes (plants that require wet conditions); (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardin and others, 1979).

Wetland Habitat: Habitat provided by shallow or deep water (but less than 6-feet deep), with or without emergent and aquatic vegetation in wetlands. Wetland habitat only exists when and where a wetland or portion of a wetland is covered with water (visible surface water). Consequently, the size and shape of "wetland habitat" will fluctuate from season-to-season and year-to-year while the size and shape of the "wetland" within which wetland habitat occurs will remain constant from season to season and from year to year. Wetlands only provide habitat for waterfowl, shorebirds, muskrats, aquatic insects, and other wetland-dependent wildlife when they contain surface water (i.e., when they provide wetland habitat).

Wildfire: A free-burning fire requiring a suppression response; all fire other than prescribed fire that occurs on wildlands (Service Manual 621 FW 1.7).

Wildland fire: A free burning fire requiring a suppression response; all fire other than prescribed fire that occurs on wildlands. Often referred to as a wildfire.

Wildlife: All non-domesticated animal life; included are vertebrates and invertebrates.

Wildlife Corridor: A landscape feature that facilitates the biologically effective transport of animals between larger patches of habitat dedicated to conservation functions. Such corridors may facilitate several kinds of traffic, including frequent foraging movement, seasonal migration, or the once in a lifetime dispersal of juvenile animals. These are transition habitats and need not contain all the habitat elements required for long-term survival of reproduction of its migrants.

Wildlife-Dependent Recreational Use: "A use of a refuge involving hunting, fishing, wildlife observation and photography, or environmental education and interpretation." These are the six priority public uses of the Refuge System as established in the National Wildlife Refuge System Administration Act, as amended. Wildlife-dependent recreational uses, other than the six priority public uses, are those that depend on the presence of wildlife. We also will consider these other uses in the preparation of refuge CCPs; however, the six priority public uses always will take precedence (Service Manual 602 FW 1.6).

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